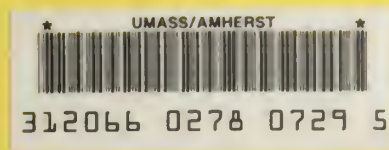


MASS. MPD3.2: H19 / Phase 2



CTPS TECHNICAL REPORT

60

GOVERNMENT DOCUMENTS
COLLECTION

OCT 21 1987

University of Massachusetts
Depository Copy

HANSCOM AREA TRAFFIC STUDY: PHASE II

July 1987

CTPS TECHNICAL REPORT 60

TITLE HANSCOM AREA TRAFFIC STUDY: PHASE II

AUTHOR(S) EFI PAGITSAS

DATE JULY 1987

ABSTRACT

Existing (1985) travel conditions were determined for a study area consisting of portions of Bedford, Concord, Lexington, and Lincoln in the vicinity of Hanscom Field. Future (1995) conditions were analyzed under a no-build case and seven alternative build scenarios. Each scenario consists of combinations of roadway and intersection improvements along the corridors of Route 2, Route 2A, and Routes 4/225. This report details the findings of the study and recommends a course of action. An executive summary of this report is available.

The first phase of the Hanscom Area Traffic Study, the relationship of which to this phase is explained in the introduction to this report, is documented in CTPS Technical Report 44 and its accompanying executive summary.

This document was prepared by **CENTRAL TRANSPORTATION PLANNING STAFF**, an interagency transportation planning staff created and directed by the Metropolitan Planning Organization, consisting of the member agencies.

Executive Office of Transportation and Construction
Massachusetts Bay Transportation Authority
Massachusetts Department of Public Works
MBTA Advisory Board
Massachusetts Port Authority
Metropolitan Area Planning Council

AUTHOR

Efi Pagitsas

PROJECT PRINCIPAL

Daniel F. Beagan

GRAPHICS

David B. Lewis


Mary Kean

Lisa Tittlemore

WORD PROCESSING

Olga Doherty

Sybil White

 MAPC REGION
BOUNDARY STUDY AREA

This study was financed by:

Massachusetts Department of Public Works (Contract 23892)

Massachusetts Port Authority (H-626)

United States Air Force

National Park Service

TABLE OF CONTENTS

1	INTRODUCTION	1
2	ALTERNATIVE HIGHWAY-NETWORK PACKAGES	3
2.1	Minimum and Maximum Impact Scenarios	3
2.2	Formulation of Alternative Packages	8
3	IMPACT ANALYSIS	9
3.1	Major Roadways	10
3.2	Support Roadways	17
3.3	Summary of Impacts by Alternative Package	26
4	CONCLUSIONS AND RECOMMENDATIONS	29
APPENDICES		
A	Updating and Improving the HATS Phase I Traffic-Forecasting Procedure	33
B	Application of the HATS II Traffic-Forecasting Model	37
C	Maps Showing Travel Conditions in the AM and PM Peak Hours Under the 1985 Base Case, the 1995 No-Build Case, and Packages 1 through 7 (itemized in List of Figures and Tables, p. v)	39



Digitized by the Internet Archive
in 2014

<https://archive.org/details/hanscomareatraff00pagi>

LIST OF FIGURES AND TABLES

FIGURES

2-1	Locations of Projects Included in the Alternative Highway-Network Packages	5
Appendix C--Travel Conditions:		39
C-1	1985 Base Case AM Peak Hour	
C-2	1985 Base Case PM Peak Hour	
C-3	1995 No-Build Case AM Peak Hour	
C-4	1995 No-Build Case PM Peak Hour	
C-5	Package 1, AM Peak Hour	
C-6	Package 1, PM Peak Hour	
C-7	Package 2, AM Peak Hour	
C-8	Package 2, PM Peak Hour	
C-9	Package 3, AM Peak Hour	
C-10	Package 3, PM Peak Hour	
C-11	Package 4, AM Peak Hour	
C-12	Package 4, PM Peak Hour	
C-13	Package 5, AM Peak Hour	
C-14	Package 5, PM Peak Hour	
C-15	Package 6, AM Peak Hour	
C-16	Package 6, PM Peak Hour	
C-17	Package 7, AM Peak Hour	
C-18	Package 7, PM Peak Hour	

TABLES

3-1	Major Roadways Included in Impact Analysis	11
3-2	Support Roadways Included in Impact Analysis	18

1 INTRODUCTION

This study is a follow-up to Phase I of the Hanscom Area Transportation Study (HATS), which was documented in Central Transportation Planning Staff (CTPS) Technical Report 44 (July 1984) and its accompanying Executive Summary. HATS Phase I examined existing (1983) and future (1995) travel conditions under a no-build alternative and five alternative build packages. The major feature of four of the packages was a ring road, which, in various alignments, connected the intersection of Routes 2 and 2A in Concord with major roadway segments (Hartwell Road, South Road, Summer Street, and Hartwell Avenue) in Bedford. The fifth package (Package 4 in the report) also included a ring road, but added the following as well: the upgrading of Route 2 to a full limited-access expressway between the Concord Rotary in Concord and Route 128 in Lexington; closure of Route 2A along Minuteman National Historic Park from Old Bedford Road and Lexington Road in Concord to the intersection of Massachusetts Avenue and Airport Road in Lexington; extension of Hanscom Drive to Route 2; a connector road between Massachusetts Avenue and Route 2; and a connector road between Hartwell Avenue in Bedford and Route 128 in Lexington.

The major findings of the Phase I analysis were stated as follows.

The proposed Ring Road, in any of the tested alignments, is not capable of restoring 1995 traffic conditions to even those of the present (1983) on an areawide basis. . . . Only in the case of coupling the Ring Road with all the major improvements included in Package 4, are future travel conditions restored to, or somewhat improved over, those of the present on a majority of roadway segments. . . . The major build alternative, Package 4, which includes not only the Ring Road but also such projects as the proposed Hartwell Avenue Connector and the upgrading of the Route 2 expressway, does far more towards providing relief from areawide traffic problems.

Based on the results of the analysis, certain courses of action were recommended to the HATS Committee. These are summarized in the following excerpts from the report.

Bedford Center/Routes 4 and 225

In order to reduce traffic congestion through Bedford Center along the Great Road (Routes 4/225), the first course of action that should be undertaken is to secure traffic improvements in the Route 3 corridor to the immediate north, most importantly to Route 3 itself.

Hartwell Avenue Area

Only through the construction of the proposed Hartwell Avenue Connector, with traffic thus carried directly onto Route 128, can significant congestion and delay relief be provided to this area.

Route 2 (Concord and Lincoln)

The proposed Ring Road will provide virtually no relief to either existing or projected problems along Route 2. . . . The Route 2 problems appear to be solvable only by an upgrading of Route 2 to expressway standards.

Route 2A (Lincoln and Lexington)

The proposed Ring Road in its full alignment will provide relief to portions of Route 2A through Lincoln. However, the eastern section--between Airport Road and the Route 128 interchange in Lexington--would continue to be heavily congested with all packages. . . .

Concord Center and West Bedford/Route 62

This area would derive major benefits in terms of reduced traffic congestion from the existence of the Ring Road, if the Ring Road commences at Route 2 (Crosby's Corner) rather than Virginia Road. Further traffic-flow improvements through the Concord Center area could be obtained by the upgrading of Route 2 to expressway status within Concord. If it were ever to come to a choice between an upgrading of Route 2 and the Ring Road, it would be more prudent to choose the upgrading rather than the Ring Road.

Virginia Road (Lincoln)

Under all alternatives studied, traffic is expected to increase on Virginia Road in Lincoln. This . . . has significant implications for the substandard intersection of Virginia Road and Old Bedford Road.

Ring Road (Concord and Bedford)

If a ring road alternative is to be further pursued, it is recommended that it be a full alignment one [beginning at the intersection of Routes 2 and 2A, and terminating at Hartwell Avenue].

In light of the results from HATS Phase I, the HATS Committee requested, through the Massachusetts Department of Public Works (MDPW), that CTPS pursue HATS Phase II. This time the study would focus on specific, implementable projects suggested by Phase I. Also, Phase II was seen as an opportunity to update certain features of the traffic-forecasting procedure used by CTPS for Phase I. The modification of the procedure is discussed in Appendix A, its application in Appendix B.

2 ALTERNATIVE HIGHWAY-NETWORK PACKAGES

2.1 MINIMUM AND MAXIMUM IMPACT SCENARIOS

Phase II of the Hanscom Area Traffic Study has dealt with seven alternative highway packages which were formulated from scenarios recommended by the HATS Committee for study. The number of scenarios recommended initially was too large to be given an appropriate level of analysis. A manageable set of scenarios was developed in the following manner. CTPS first grouped the scenarios in the initial set by subarea or corridor within the study area. Three areas were revealed to be of concern to all committee members: the corridors of Route 2, Route 2A, and Routes 4/225. Next, from the description of the initial scenarios and in consultation with representatives of the study's funding agencies, minimum and maximum impact scenarios were defined for each of the three corridors, as documented in the CTPS memorandum, "HATS II Alternative Packages" (Efi Pagitsas, December 26, 1985). The definitions of these scenarios given below are taken from this memorandum. Figure 2-1 locates the projects implied by the scenarios on a map of the area.

Route 2 Corridor

Minimum: "Existing (1985) condition."

Maximum: "Grade separation of the intersections Route 2/Cambridge Cutoff (Crosby's Corner) in Concord and Route 2/Bedford Road in Lincoln."

This has been taken to mean the following.

- o Route 2 between Bedford Road and Brooks Road (Location 1) is a four-lane (two lanes in each direction), median-divided facility.
- o Immediately west of the location Route 2/Brooks Road in Lincoln, commences a flyover, two-lane, one-way west-bound segment of Route 2 which terminates at the intersection of Route 2 with Sandy Pond Road in Concord. The eastbound segment of Route 2 between Sandy Pond Road and Brooks Road is constructed at grade as a two-lane facility (Location 2).

- o The present intersection at Crosby's Corner is maintained as is, for the accommodation of local traffic between Concord Center and Routes 2 and 2A. The present section of Route 2 between Sandy Pond Road and Crosby's Corner becomes a two-lane slip off/on ramp to Route 2. The segment of Route 2 between Crosby's Corner and Brooks Road also becomes a two-lane slip on/off ramp. The traffic signal and the roadway widths of the Cambridge Turnpike and Cambridge Cutoff remain as they are.
- o The signalized intersection of Route 2/Bedford Road in Lincoln (Location 3) is replaced by a grade-separated interchange. Bedford Road, which becomes a flyover at the point where it intersects with Route 2, is maintained at its present width.

Route 2A Corridor

Minimum: "New road between Hanscom Drive and new Massachusetts Avenue with Route 2A and Old Massachusetts Avenue closed. Merriam's Corner, Airport Road, Mill Street and Bedford Road remain open."

This has been taken to mean the following.

- o Relocation of the eastern portion of Route 2A between Hanscom Drive in Lincoln and Massachusetts Avenue in Lexington (Location 4). The roadway width of the relocated Route 2A remains as is.
- o Old Massachusetts Avenue is closed to traffic.
- o Hanscom Drive and Airport Road are extended southward to connect with the relocated Route 2A. Mill Street also connects with the new Route 2A.
- o Route 2A west of Hanscom Drive remains at its present alignment, with traffic access to all currently intersecting roadways.

Maximum: "New road between Hanscom Drive and Massachusetts Avenue with all crossroads closed. Route 2A closed between Merriam's Corner and Hanscom Drive. New Route 2A from Crosby's Corner to Virginia Road, Airport Road closed."



Package No. Locations of Projects Included

1	D,E,G
2	D,E,F
3	A,B,C,D,G
4	A,B,C,D,F
5	D,G
6	D,F
7	A,B,C,D,E,G

Location No.

Name of Project*

A	Route 2, Four-lane, Median Divided
B	Crosby's Corner Fly-over
C	Route 2 / Bedford Road, Grade Separation
D	Eastern Relocation of Route 2A
E	Western Relocation of Route 2A
F	Bedford Street, Widening to Four Lanes
G	Hartwell Connector

* For full description, see text.

This has been taken to mean the following.

- o Relocation of Route 2A between Hanscom Drive and Massachusetts Avenue (Location 4); Hanscom Drive extended to the new alignment of Route 2A; no traffic access to Airport Road; Old Massachusetts Avenue closed.
- o Route 2A west of Hanscom Drive to Crosby's Corner, and Lexington Road from Route 2A to Merriam's Corner (Lexington Road at Old Bedford Road) are closed. No traffic access is provided to Bedford Road, Bedford Lane, Sunnyside Lane, and Brooks Road.
- o Construction of a two-lane, undivided roadway (Location 5) commencing at the Route 2/Route 2A intersection (Crosby's Corner) in Concord and proceeding over the existing Route 2A (Cambridge Cutoff) right-of-way to the present Route 2A/Lexington Road intersection. Continuing in a northeasterly direction, the proposed connector intersects with Virginia Road, at grade, at a point to the north of Old Bedford Road in Lincoln, where it also terminates. Upgrading of Virginia Road between the connector and Old Bedford Road.

Routes 4/225 Corridor

Minimum: "Improve Bedford Street to four lanes."

- o This has been taken to mean the reconstruction of Bedford Street (Routes 4/225 in Lexington, Location 6) between Hartwell Avenue and Route 128 to a four-lane, undivided roadway.

Maximum: "Extension of Wiggins Avenue to Hartwell Avenue and thence to Route 128."

- o This has been taken to mean the construction of a four-lane Hartwell Avenue Connector (Location 7) commencing at the intersection of Wiggins Avenue with Summer Street in Bedford. From this point, it proceeds southward as an extension of Wiggins Avenue until reaching the vicinity of the northeast corner of the Massport property line. Then it proceeds in a generally southeasterly direction in Lexington, where it intersects with Hartwell Avenue and Route 128. The connection with Route 128 is assumed to be a system of slip on/off ramps and service roadways.

2.2 FORMULATION OF ALTERNATIVE PACKAGES

The seven alternative packages are combinations of the minimum and maximum impact scenarios for the three corridors, as shown in the table below.

The HATS Phase II Alternative Packages as
Combinations of Minimum and Maximum Scenarios
for the Corridors of Rt. 2, Rt. 2A and Rts. 4/225

<u>Corridor</u>	<u>Alternative Packages</u>						
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
Route 2	Min	Min	Max	Max	Min	Min	Max
Route 2A	Max	Max	Min	Min	Min	Min	Max
Routes 4/225	Max	Min	Max	Min	Max	Min	Max

Figure 2-1 (page 5) provides a definition of each package in terms of the specific projects it comprises.

In addition, to the projects included in any package, it is assumed that, by the year 1995: two more lanes (one per direction) will have been added to Route 3 between Route 128 and the Burlington town line; and a two-lane "jug handle" ramp for left turns will have been constructed at the intersection of Bedford Street (Routes 4/225) with Hartwell Avenue.

3 IMPACT ANALYSIS

The impact analysis in this study included comparison of traffic volumes on roadway segments, but was based primarily on comparison of volume-to-capacity (v/c) ratios, ranges of which were applied as criteria for the identification of various levels of congestion. The ranges which were used in this study (and in HATS Phase I) are shown in the table below.

Ranges of Volume-to-Capacity Ratios and Levels of Congestion

<u>Congestion Level</u>	<u>Volume/Capacity Range</u>	<u>Description of Travel Condition</u>
1	0.00-0.59	Light volumes of relatively free-flowing traffic
2	0.60-0.79	Moderate volumes of relatively smooth-flowing traffic
3	0.80-0.94	Moderate to heavy volumes of relatively slow, but steadily moving traffic
4	0.95-1.14	Heavy volumes of relatively slow traffic, subject to fluctuations in operating conditions and temporary restrictions of flow
5	1.15-1.49	Volumes that substantially exceed the capacity of the roadway, with resultant unstable flow and possible stoppage for extended periods of time
6	1.50+	

AM- and PM-peak-hour congestion levels on roadway segments in the study area were estimated for each of the seven alternative highway packages and for a 1995 no-build highway network. Figures C-1 through C-18 (in the final appendix of this report) plot these travel conditions and 1985 base conditions by means of a series of symbols on a map of the area's roadways.

Impacts are discussed in the three sections below, in terms of major roadways, support roadways, and the alternative packages. (Note that, in these discussions, "present" conditions are base-year--1985--conditions; "future" conditions are horizon-year--1995--no-build conditions, unless otherwise specified; and conditions under the alternative packages are 1995 projections.)

3.1 MAJOR ROADWAYS

The major roadways that were examined for impacts are listed in Table 3-1. The traffic impacts on these roadways were analyzed by first comparing the 1985 volumes and volume-to-capacity ratios from the existing-network assignments to the 1995 volume and volume-to-capacity ratios for the same network with an upgraded Route 3 (future no-build). Next, comparison was made, for the same parameters, between the future no-build network and each of the future (1995) networks under the alternative packages. The findings from this analysis are reported below for each major roadway in the same format as that used in the analysis. Generally, for each roadway, all comparisons are made first for the AM peak hour, and then for the PM peak hour.

Route 2 (Concord) from Route 62 to Crosby's Corner

During the AM peak hour, this segment is presently near or at capacity in the eastbound direction, near or below capacity in the westbound direction. It is projected that 1995 no-build travel conditions will be worse in the eastbound direction and approximately the same in the westbound direction. These same 1995 travel conditions would be expected under any of the seven packages.

During the PM peak hour, westbound volumes on this segment of Route 2 are near or at capacity between Crosby's Corner and Sudbury Road, and over capacity between Sudbury Road and Route 62. In the eastbound direction, travel conditions are better by at least one level of congestion. It is expected that no-build travel conditions will be worse in 1995, especially in the westbound direction. Under Packages 1 and 2, this same 1995 situation would be expected, since the western relocation of Route 2A brings only marginally higher traffic to this segment of Route 2 than is projected under the future no-build option. Under Packages 3 and 4, travel conditions improve significantly over the future no-build between Crosby's Corner and Sandy Pond Road, with the rest of the segment remaining the same. Under Packages 5 and 6, conditions are the same as under the future no-build. Package 7 has the same effect on this segment of Route 2 as Packages 3 and 4.

Route 2 (Lincoln and Lexington) from Crosby's Corner to Route 128

During the AM peak hour, this segment is near capacity eastbound, and below capacity with good flow conditions in the westbound direction. By 1995, a deterioration is expected in the eastbound direction to capacity or over-capacity levels. Packages 1, 2, 5, and 6 are expected to have a neutral effect on 1995 no-build conditions. Under Packages 3, 4, and 7, travel conditions are expected to be restored to the present level of service.

<u>Roadway</u>	<u>Community</u>	<u>Termini of Segment</u>
Route 2	Concord	Route 62 to Crosby's Corner
Route 2	Lincoln & Lexington	Crosby's Corner to Route 128
Route 2A (Great Road)	Lincoln	Cambridge Turnpike Cutoff to Bedford Road
Route 2A (Great Road) (Massachusetts Avenue)	Lincoln	Bedford Road to Marrett Road
Route 2A (Marrett Road)	Lexington	Great Road to Route 128 Interchange
Routes 4/225 (North Road)	Bedford	Carlisle Road to Great Road
Routes 4/62/225 (Great Road)	Bedford	Concord Road to Brooksbie Road
Routes 4/225 (Great Road)	Bedford	Brooksbie Road to Shawsheen Road
Routes 4/225 (Great Road) (Bedford Street)	Bedford	Shawsheen Road to Hartwell Avenue
Routes 4/225 (Bedford Street)	Lexington	Hartwell Avenue to Route 128 Interchange
Route 3	Bedford & Burlington	Route 128 to Bilerica Town Line
Route 62 (Main Street)	Concord	Route 2 to Monument Square
Route 62 (Bedford Street)	Concord	Monument Square to Old Bedford Road
Route 62 (Old Bedford Road) (Concord Road)	Concord	Bedford Street to Hartwell Road
Route 62 (Concord Road)	Bedford	Hartwell Road to Great Road (Routes 4/225)
Western Relocation of Route 2A	Lincoln & Concord	Virginia Road to Crosby's Corner
Hartwell Connector	Bedford & Lexington	Wiggins Avenue to Hartwell Avenue
Hartwell Connector	Lexington	Hartwell Avenue to Route 128
Hanscom Drive	Lincoln	Route 2A (Great Road) to Old Bedford Road
Airport Road	Lincoln	North of Route 2A (Great Road)
Old Bedford Road	Lincoln	Hanscom Drive to Virginia Road
Virginia Road	Lincoln	Old Bedford Road (Lincoln) to Old Bedford Road (Concord)

Hanscom Area Traffic
Study: Phase II

Technical Report 60
July 1987

MAJOR ROADWAYS INCLUDED IN
IMPACT ANALYSIS

CTPS

TABLE

3-1

During the PM peak hour, this segment of Route 2 presently operates at near-capacity levels in the westbound direction. The flow conditions in the eastbound direction are good. It is expected that in 1995, it will be even more congested in the peak direction but will be roughly the same in the opposite direction. Under Packages 1, 2, 5, and 6, where Route 2 is assumed to remain unmodified, travel conditions are the same as no-build conditions. Under Packages 3, 4, and 7, the travel conditions improve to acceptable levels in the westbound direction. The eastbound direction also improves, but remains within the same congestion-level category.

Route 2A (Great Road, Lincoln) from Cambridge Turnpike Cutoff to Bedford Road

During the AM peak hour, this roadway segment has unstable traffic-flow conditions in the eastbound direction, good travel conditions in the opposite direction. Deterioration in the eastbound direction is expected by 1995. This portion of Route 2A is relocated in Packages 1, 2, and 7, and is examined later in this major roadways section as the western relocation of Route 2A. Under Packages 3 and 4, the capacity improvements on Route 2 are expected to relieve this segment of Route 2A, restoring eastbound travel conditions to the present congestion level. Travel conditions under Packages 5 and 6 are projected to be similar to those under the future no-build option.

During the PM peak hour, congestion levels on this section are less than acceptable in both directions, with eastbound travel slightly easier than westbound. By 1995, congestion and delays are expected to have worsened, mostly in the westbound direction. In Packages 1, 2, and 7, this roadway segment is replaced by the relocated western portion of Route 2A. Under Packages 3 and 4, the upgrading of Route 2 lowers the congestion and delays on this section to present or better levels in both directions. The relocation of the eastern portion of Route 2A, in Packages 5 and 6, has somewhat less impact on the travel conditions along this section than Packages 3 and 4.

Route 2A (Great Road, Lincoln, and Massachusetts Avenue, Lexington) from Bedford Road to Marrett Road

During the AM peak hour, this segment operates at conditions ranging from marginally tolerable to forced-flow in the eastbound direction, and no relief is expected under the future no-build option. In the westbound direction, travel conditions are presently acceptable, but some deterioration is expected in the future at one location. In Packages 1, 2, and 7, the portion of this segment between Bedford Road and Hanscom Drive is closed, owing to the western relocation; the portion between Hanscom Drive and Marrett Road shows an improvement in travel conditions.

Under Packages 3 and 4, the Route 2 capacity increases provide relief to Route 2A, both eastbound and westbound, resulting in a significant improvement in conditions over both the no-build case and the present situation. Packages 5 and 6 do not offer any relief to this segment of Route 2A in either direction.

During the PM peak hour, travel conditions are less than acceptable, as on the segment of Route 2A discussed immediately above. No relief is expected in the future under the existing network configuration. Under Packages 1 and 2, the eastern portion of the relocated segment has acceptable travel conditions, a marked improvement over conditions with the no-build alignment. The improvement is mainly attributable to the elimination of conflicts in the vicinity of Hanscom Drive following the closure of Route 2A west of there. Packages 3 and 4 also offer relief to this section (though not as much as Packages 1 and 2), as in the AM peak hour. Under Packages 5 and 6, where only the eastern relocation of Route 2A occurs, travel conditions are only marginally better than in the no-build case. Under Package 7, the segment attains free-flow conditions--a significant improvement over the base and no-build cases--because it benefits directly from both the upgrading of Route 2 and the eastern and western relocation of Route 2A.

Route 2A (Marrett Road, Lexington) from Great Road to Route 128 Interchange Area

During the AM peak hour this roadway segment is presently at marginally tolerable travel conditions in both directions, with no change expected in the future no-build case. The relocation of Route 2A in Packages 1 and 2 is expected to benefit the westbound direction, but not the eastbound direction. In fact, eastbound conditions are projected to deteriorate under Package 2, with Airport Road assumed closed to traffic and the Hartwell Connector not present to channel traffic to Route 128. Packages 3, 4, and 7 improve travel conditions on Marrett Road to better than present levels. The eastern relocation of Route 2A in Packages 5 and 6 also benefits Marrett Road, in the westbound direction mostly.

During the PM peak hour, this roadway segment operates at capacity in both directions, with further worsening in the future no-build case. All packages improve travel conditions to marginally acceptable levels, although Packages 5 and 6 are less effective than the rest. In general, there is an indication that the presence of the Hartwell Connector in Lexington improves the quality of travel on Marrett Road eastbound. Also, in Package 1, Marrett Road eastbound benefits from the closure of Airport Road, since base traffic exits the area via Wood Street and the Hartwell Connector.

Routes 4 and 225 (North Road, Bedford) from Carlisle Road to Great Road)

During both the AM and PM peak hours, this section of North Road is badly congested in both directions. It is expected that the situation will be even worse in the future, under no-build conditions. There is no strong evidence to suggest that the flow conditions on this roadway segment will be improved by any of the packages, not excepting those that include the Hartwell Connector.

Routes 4/62/225 (Great Road, Bedford) from Concord Road to Brooksbie Road

During the AM peak hour, this segment has marginally tolerable conditions in the eastbound direction which are expected to deteriorate to forced-flow levels in the future. The same congestion levels are expected to prevail under all packages.

During the PM peak hour, this section experiences long delays westbound, owing to congestion, mostly between Hillside Avenue and Brooksbie Road. In the eastbound direction, travel conditions are tolerable to good. In the future, the same, if not a worse, travel situation is expected. As with the segment of Routes 4/225 discussed in the section immediately above, there is no evidence to indicate that congestion and delay will be eased under any of the seven packages, not excepting those that include the Hartwell Connector.

Routes 4 and 225 (Great Road, Bedford and Bedford Street, Lexington) from Brooksbie Road to Hartwell Avenue

During the AM peak hour, eastbound travel conditions on this segment, like those on the segment discussed immediately above, are marginally tolerable and expected to deteriorate to forced-flow levels in the future. Westbound travel, presently at acceptable congestion levels, is expected to deteriorate to marginally acceptable levels. The packages which include the widening of Bedford Street and, even more so, those containing the Hartwell Connector are expected to have a positive impact on the westbound travel of this section, mostly between Shawsheen Road and Hartwell Avenue.

During the PM peak hour, this roadway segment is badly congested in both directions. It is expected that flow conditions will be worse in the future. There is no evident impact from the construction of the Hartwell Connector or from any other projects included in the packages.

Routes 4 and 225 (Bedford Street, Lexington) from Hartwell Avenue to Route 128 Interchange

During both the AM and PM peak hours, this roadway segment is seriously congested in both directions of travel, and the same is expected in the future.

Neither the Hartwell Connector nor the widening of Bedford Street to four lanes is of much assistance to this roadway. The easing of congestion which would result from either of these projects would quickly attract traffic presently using Page Road (which is parallel to Bedford Street, to the north). However, it should be noted that, of these two groups of packages--those that include the Hartwell Connector and those that include the widening of Bedford Street--the latter are more beneficial to Bedford Street, because the total supply of relevant capacity which they offer is essentially higher. Also, the jug-handle ramp at Bedford Street and Hartwell Avenue, which is included in all packages, will be beneficial.

Route 3 (Burlington and Bedford) from Route 128 to Billerica Town Line

During the AM peak hour, Route 3 operates at a marginally tolerable level of congestion southbound, and at an acceptable level of congestion northbound. During the PM peak hour, the exact reverse is happening. In the future no-build case, assuming the widening of Route 3 to three lanes, travel conditions are expected to improve significantly: to acceptable in the peak direction and good in the off-peak direction. Under all seven packages, the effects of the widening in the AM and PM peak hours remain the same as in the future no-build case.

Route 62 (Main Street, Concord) from Route 2 to Monument Square

During both the AM and PM peak hours, this segment of Route 62 experiences moderate to severe congestion and delays in the peak direction and only rather minor congestion in the off-peak direction. Due to increased volumes in the future, this roadway segment will suffer additional delays in the peak direction in the AM peak hour and in both directions in the PM peak hour. All of the packages, not excepting those that include improvements on Route 2, the relocation of Route 2A, or the Hartwell Connector, have a neutral traffic impact on this portion of Route 62.

Route 62 (Bedford Street, Concord) from Monument Square to Old Bedford Road

During the AM peak hour this roadway segment is at or near capacity eastbound; during the PM peak hour, it is at or over capacity westbound. Travel conditions in the off-peak direction are good, and are expected to remain within acceptable congestion levels in the future. None of the packages has a significant impact.

Route 62 (Old Bedford Road, Concord, and Concord Road, Bedford) from Bedford Street to Hartwell Road

During both the AM and PM peak hours, in the northbound and southbound directions, respectively, this segment of Route 62 is loaded well beyond its capacity south of Davis Road in Bedford but is below capacity between Davis Road and Hartwell Road. The improvements in the corridors of Routes 2 and 2A have an insignificant effect on this roadway. However, there is evidence that under the packages which include the Hartwell Connector conditions improve slightly in both peak hours, owing to the slight reduction in traffic entering and exiting Hartwell Road.

Route 62 (Concord Road, Bedford) from Hartwell Road to Great Road (Routes 4/225)

During the AM peak hour, this roadway segment is suffering from severe congestion in the westbound direction, and no change is expected in the future. Eastbound, AM-peak-hour congestion levels are marginally acceptable, and slight deterioration is expected in the future. During the PM peak hour, this roadway segment is operating at capacity in both directions. In the future, PM-peak-hour conditions are expected to deteriorate further in the eastbound direction and stay the same in the westbound direction. There is no evidence that the Hartwell Connector or other improvements will affect the flow conditions on this segment of Route 62 during either of the peak hours.

Western Relocation of Route 2A from Crosby's Corner (Concord/Lincoln) to Virginia Road (Lincoln)

This section of Route 2A is included only in Packages 1, 2, and 7, where it is expected to function at an acceptable congestion level. Volumes are expected to be slightly higher than future volumes on the Cambridge Turnpike Cutoff; however, they will be free-flowing.

Hartwell Connector (Lexington) from Wiggins Avenue to Hartwell Avenue

This small section of the connector is projected to function, in general, at tolerable levels of congestion during both peak hours, with minor differences between packages.

Hartwell Connector (Lexington) from Hartwell Avenue to Route 128

The Hartwell Connector exists in Packages 1, 3, 5, and 7 only. Under all of these packages, the connector is expected to be used by a number of trips to and from the Raytheon complex and the northern Bedford area. Under Packages 1 and 7, in which Airport Road is closed to traffic, the connector is also expected to act as a relief valve for Wood Street during both peak hours, at which times it is projected to be at or over capacity in the eastbound direction and under capacity in the westbound direction. Under Packages 3 and 5, in which Airport Road is open to traffic, travel on the connector is expected to be, although subject to congestion and delays, generally better than under Packages 1 and 7.

Hanscom Drive (Lincoln) from Great Road (Route 2A) to Old Bedford Road

The good travel conditions that prevail along this roadway segment (except at its intersection with Route 2A) are projected to continue into the future under all packages, during both peak hours. Packages 1, 2, and 7 are not exceptions, although they are expected to result in significant increases in volume, owing to the closure of Route 2A west of Hanscom Drive.

Airport Road (Lincoln), North of Great Road (Route 2A)

During the AM peak hours, this roadway is heavily congested in the northbound direction, moderately in the southbound. The reverse is observed during the PM peak hour. This situation continues in the future no-build case and under Packages 3, 4, 5, and 6, in which it remains open to traffic.

Old Bedford Road (Lincoln) from Hanscom Drive to Virginia Road

This roadway operates at quite satisfactory levels of congestion and delay during both peak hours. No deterioration is expected in the future no-build case or in Packages 3, 4, 5, and 6. In Packages 1, 2, and 7, owing to the additional traffic attracted to the relocated Route 2A, the congestion on the roadway segment is expected to increase within tolerable levels, however.

Virginia Road (Lincoln/Concord) from Old Bedford Road (Lincoln) to Old Bedford Road (Concord)

This roadway segment operates at low congestion and delay levels during both peak hours, and is expected to continue to do so into the future. The increase in traffic which is expected under Packages 1, 2, and 7 between Old Bedford Road and the relocated Route 2A will not significantly affect the future performance of this roadway.

3.2 SUPPORT ROADWAYS

The support roadways that were examined for impacts are listed in Table 3-2. The impact analysis for the support roadways is presented in the same format as for the major roadways. First the existing (base-year 1985) and future (horizon-year 1995) no-build travel conditions are presented, assuming no intervening changes in the roadway network other than the upgrading of Route 3. Next, the conditions resulting from the alternative packages are compared with future no-build conditions.

Hartwell Road (Bedford) from Route 62 (Concord Road) to South Road

Hartwell Road is congested in the direction of travel approaching the Raytheon facilities during the AM peak hour and the opposite direction during the PM peak hour. The roadway is expected to become significantly more congested in the future.

<u>Roadway</u>	<u>Termini of Segment</u>
<u>Bedford</u>	
Hartwell Road	Route 62 (Concord Road) to South Road
Route 4 (North Road)	Pine Hill Road to Carlisle Road
South Road	Great Road to Hartwell Road
South Road	Hartwell Road to Summer Street
Summer Street	South Road to Maguire Road
Wiggins Avenue	Walsh/Ashby to Summer Street
Walsh/Ashby	Great Road to Wiggins Avenue
Support Roadways in North Bedford and North Lexington	Between Routes 4/225 and Route 3
<u>Concord</u>	
Lexington Road	Monument Square to Merriam's Corner
Lexington Road	Merriam's Corner to Great Road (Route 2A)
Cambridge Turnpike	Lexington Road to Crosby's Corner
Old Bedford Road	Merriam's Corner to Route 62 (Bedford Street)
Route 126 (Concord Road)	South of Route 2
Sandy Pond Road	South of Route 2
Sudbury Road	Route 2 to Thoreau Street
Sudbury Road	Thoreau Street to Main Street
Walden Street	Route 2 to Thoreau Street
Walden Street	Thoreau Street to Main Street
Thoreau Street	Walden Street to Main Street
<u>Lexington</u>	
Hartwell Avenue	Bedford Street to Maguire Road
Hartwell Avenue	Maguire Road to Wood Street
Westview Street	Maguire Road to Hartwell Avenue
Maguire Road	Summer Street to Hartwell Avenue
Wood Street	Hartwell Avenue to Old Massachusetts Avenue
<u>Lincoln</u>	
Bedford Road	South of Route 2
Bedford Road	Route 2 to Route 2A (Great Road)
Lexington Road	South of Route 2

Hanscom Area Traffic
Study: Phase II

Technical Report 60
July 1987

SUPPORT ROADWAYS INCLUDED IN
IMPACT ANALYSIS

CTPS

TABLE

3-2

Because Hartwell Road carries mostly local trips, the travel conditions on it are not affected extensively by any of the packages. There is some evidence that the Hartwell Connector will attract a number of Raytheon commuters during both peak hours who previously used facilities to the west of Raytheon. However, this shift is slight and, while it affects the southbound travel on Route 62 somewhat (as mentioned earlier), Hartwell Road remains within the limits of the congestion index that applies under the other packages and in the future no-build case.

Route 4 (North Road, Bedford) from Pine Hill Road to Carlisle Road (Route 225)

During both peak hours, the presently acceptable travel conditions in the southbound direction are projected to become significantly congested in the future. In the northbound direction, travel conditions are marginally acceptable, with no change expected in the future. The southbound direction appears to be negatively affected by packages containing the Hartwell Connector, during both peak hours.

South Road (Bedford) from Great Road to Hartwell Road

The portion of this segment that is north of Loomis Street operates at acceptable travel conditions in both directions, during both peak hours. Between Loomis Street and Hartwell Road, the congestion and delays are serious, especially in the southbound direction during the AM peak hour and in the northbound direction during the PM peak hour. No change of this situation is expected under any of the packages.

South Road (Bedford) from Hartwell Road to Summer Street

At present, this portion of South Road operates at a marginally acceptable congestion level in the southbound direction during the AM peak hour and in the northbound direction during the PM peak hour; it operates at an acceptable level of congestion in the opposite directions. The situation is not expected to change in the future.

This roadway segment is seriously affected by the packages which include the Hartwell Connector. Most of the impact is on the southbound direction, where volumes increase owing to the connector's attracting traffic bound for Route 128.

Summer Street (Bedford) from South Road to Maguire Road (Lexington)

The moderate congestion now present during the AM peak hour in both directions is expected to become severe in the future. During the PM peak hour, the roadway is already seriously congested in both directions, with no improvement expected in the future. All of the alternative packages which include the Hartwell Connector have a negative effect on travel in both directions, during both peak hours.

Wiggins Avenue (Bedford) from Walsh/Ashby to Summer Street

The use of this roadway is controlled by the Walsh/Ashby connection to the north. Because of this restriction, peak-hour travel conditions are acceptable in the peak direction (southbound in the morning, northbound in the evening) and good in the off-peak direction. In the future, the situation deteriorates in the peak direction and remains good in the off-peak direction.

This is another roadway segment negatively affected by the Hartwell Connector, which actually begins at the terminal point of Wiggins Avenue. The deterioration is more severe in the southbound direction, which is also affected by conflict with the increased westbound traffic on Summer Street. Under packages which include the widening of Bedford Street, the congestion level of this roadway improves to acceptable levels in both directions.

Walsh/Ashby (Bedford) from Great Road to Wiggins Avenue

Southbound AM-peak-hour travel is seriously congested, and will deteriorate further in the future. The uncongested northbound travel conditions are expected to continue into the future. During the PM peak hour, these roadway segments operate at extremely serious congestion levels, which are expected to continue. None of the alternative packages has a favorable impact on Walsh/Ashby.

Support Roadways in Northern Bedford and Northern Lexington between Routes 4/225 and Route 3

Before describing the effects of the seven packages on the roadways of northern Bedford and northern Lexington, it is important to explain the function of these roadways with respect to major facilities in the area. This group of support roadways consists of Pine Hill Road/Page Road/Grove Street, the orientation of which is primarily east/west, and the primarily north/south Spring Road, Brooksbie Road, Old Billerica Road, Route 62, Shawsheen Road, Winter Street, and Eldred Street. Page/Pine Hill/Grove is parallel to Routes 4/225, and functions in part as an alternative to that major facility. The north/south roadways act as distributors and collectors of traffic to and from Route 3, Middlesex Turnpike, and other roadways to the north. For example, a number of trips from northern Bedford with destinations served by Route 128 use the north/south roadways in the evening to reach Route 3 southbound and thence Route 128. In general, the support roadways in this area are sensitive to the quality of flow on Route 3 and Route 128 and to the available capacity along the corridor of Routes 4/225.

Presently, during the AM peak hour, the north/south roadways Spring Road, Brooksbie Road, Old Billerica Road, Route 62, and Shawsheen Road operate at tolerable levels of congestion southbound and under quite acceptable travel conditions northbound.

Winter and Eldred streets operate under forced-flow conditions southbound and relatively uncongested conditions northbound. Pine Hill Road/Page Road/Grove Street travel conditions overall are in both directions acceptable except for the westbound conditions between Route 128 in Lexington and Wilson Road in Bedford.

During the PM peak hour, present southbound conditions are satisfactory overall, while there are tolerable disturbances in the northbound direction along Spring Road, Old Billerica Road, Route 62, Shawsheen Road, Winter Street, and Eldred Street.

In the future no-build case, the growth of peak-hour traffic is expected to affect both directions of travel on the north/south roadways and the peak direction on Page/Pine Hill Road. The flow of traffic is expected to become especially unstable northbound in the PM peak hour on Spring Road (south of Pine Hill Road) and Route 62 (north of Routes 4/225), and southbound in the AM peak hour on Brooksbie Road, Shawsheen Road, Winter Street, and Eldred Street.

The improvements along Route 2 and Route 2A are expected to leave this area unaffected. However, the widening of Bedford Street and the construction of the Hartwell Connector are expected to affect the travel patterns and conditions on these roadways. In general, the widening of Bedford Street is expected to encourage northbound traffic along the north/south roadways, as a number of trips destined to the north of Routes 4/225 are projected to switch to travel paths which include Bedford Street.

The Hartwell Connector is expected to change the direction of travel for a number of trips destined to Route 128 south during the PM peak hour. Comparison of the travel conditions on this part of the network (see Figures C-3 through C-18) between Packages 1, 3, 5, and 7, which include the Hartwell Connector, and Packages 2, 4, and 6 and the no-build case, which do not, reveals a southward attraction to it through the north/south collectors to Wiggins Avenue and thence Route 128. This "pull" has a general negative impact on southbound travel conditions in this area and benefits northbound conditions.

Lexington Road (Concord) from Monument Square to Merriam's Corner

Existing travel conditions during the AM peak hour are at acceptable congestion levels, with minor deterioration expected in the future. During the PM peak hour, this segment is at capacity in both directions at present, and is expected to suffer further deterioration in the westbound direction in the future.

Under Packages 1, 2, and 7, in which the present Route 2A is closed to traffic east of Merriam's Corner, this roadway segment shows traffic-volume reductions that would improve conditions to existing or better levels. The reductions are attributable to the additional travel time needed under these packages to arrive at Merriam's Corner via Hanscom Drive, Old Bedford Road (Lincoln), Virginia Road, and Old Bedford Road (Concord).

The benefits to Lexington Road from the rest of the packages are marginal.

Lexington Road (Concord) from Merriam's Corner to Great Road (Route 2A)

Presently, in both directions of travel, congestion levels on this roadway segment are marginally acceptable in the PM peak hour and quite acceptable in the AM peak hour. This is projected to continue into the future.

In Packages 1, 2, and 7, this portion of Lexington Road is closed to traffic. Packages 3 and 4, in which Route 2 improvements are in effect, have a beneficial impact on it in the eastbound direction, where congestion improves to acceptable or better levels. Packages 5 and 6, the minimum alternatives for the corridors of Route 2 and 2A, have no effect on this roadway segment.

The Cambridge Turnpike (Concord) from Lexington Road to Crosby's Corner

The Cambridge Turnpike is presently at capacity in the peak direction and near capacity in the off-peak direction, and no change is expected. Under Packages 1, 2, and 7, the Cambridge Turnpike is expected to act as a surrogate to Lexington Road (which is closed to traffic east of Merriam's Corner) for Route 62-bound traffic during the PM peak hour. Therefore, an increase in traffic east of Hawthorne Lane is expected. In Packages 3 and 4, an increase in traffic is also expected, since travel through Crosby's Corner is significantly easier under these packages. The effect of Packages 5 and 6 is approximately the same as the future no-build case.

Old Bedford Road (Concord) from Merriam's Corner to Route 62 (Bedford Street)

Presently, the travel conditions on this roadway segment are quite acceptable, with free-flowing traffic southbound in the AM peak hour and northbound in the PM peak hour, though conditions are somewhat worse in the opposite directions. A deterioration in conditions is projected for the future in the peak direction of travel, but conditions will remain acceptable in the off-peak direction.

In Packages 1, 2, and 7, Old Bedford Road is expected to benefit from the western relocation of Route 2A, since it no longer will be used by travelers destined for Route 2A eastbound. The improvements to Route 2 in Packages 3 and 4 and the eastern relocation of Route 2A in Packages 5 and 6 have marginal effects on this roadway segment.

Route 126 (Walden Street, Concord, and Concord Road, Lincoln),
South of Route 2

The traffic on this roadway is expected to increase in the future, with negative effects on congestion and delay. Packages 1, 2, 5, and 6 have a neutral effect, overall. However, the positive effects of the Route 2 improvements in Packages 3, 4, and 7 are significant, with travel conditions improving even over the present ones.

Sandy Pond Road (Concord/Lincoln), South of Route 2

The current relatively free-flow conditions are projected to deteriorate only slightly in the future no-build case and under Packages 1, 2, 5, and 6. Packages 3, 4, and 7 reestablish current travel conditions on Sandy Pond Road in both the AM and PM peak hours.

Sudbury Road (Concord) from Route 2 to Thoreau Street

This roadway segment presently operates over capacity in the peak direction during both the AM and PM peak hours. This is expected to continue unchanged in the future no-build case and under all packages.

Sudbury Road (Concord) from Thoreau Street to Main Street

The present low congestion level is projected to continue in the future. None of the alternative packages affects this roadway segment.

Walden Street (Concord) from Route 2 to Thoreau Street

The presently acceptable congestion levels in both directions on this segment are expected to deteriorate significantly in the future, especially northbound in the AM peak hour. No significant variation from the no-build case is expected in the future under any package.

Walden Street (Concord) from Thoreau Street to Main Street

Travel conditions, acceptable at present, are projected to deteriorate only marginally in the future during the AM and PM peak hours. The same situation is expected under all seven packages.

Thoreau Street (Concord) from Walden Street to Main Street

This roadway segment presently operates under acceptable travel conditions during the two peak hours. A moderate deterioration, mostly northbound, is foreseen in the future no-build case and under all of the packages.

Hartwell Avenue/Westview Street/Maguire Road (Lexington)

During the peak hours, the congestion here is found mainly in the peak direction on Westview (eastbound AM, westbound PM) and Maguire (southbound AM, northbound PM); conditions in the non-peak directions on these streets and on Hartwell Avenue in general are acceptable. A worsening of the situation during both peak hours is expected in the future, within tolerable limits.

All packages that include the Hartwell Connector are expected to upgrade the travel conditions on these roadway segments to at least present levels. The widening of Bedford Street in the rest of the packages does not provide significant relief to this area, owing to the large number of trips with origins or destinations here.

Hartwell Avenue (Lexington) from Maguire Road to Wood Street

The moderate-to-good travel conditions prevailing on this roadway will continue in the future no-build case. Hartwell Avenue is affected mostly by Packages 1, 2, and 7, under which travel conditions deteriorate to marginally acceptable levels overall. The cause of this is the combined effect of the Hartwell Connector and the closure of Airport Road to traffic.

Under Package 1, the southbound direction of travel in the AM peak hour and the northbound in the PM are expected to be at capacity, owing to the Air Force Base traffic exiting or entering via the Wood Street gate; the off-peak directions are projected to have acceptable travel conditions during both peak hours. Under Package 2, the roadway is expected to be approaching capacity in the southbound direction in both directions in the PM. Package 7 has the same effect as Package 1. The rest of the packages do not interact with the travel conditions of this segment of Hartwell Avenue.

Wood Street (Lexington) from Hartwell Avenue to Old Massachusetts Avenue

During the AM peak hour, the segment of Wood Street south of the Air Force Base gate is over capacity northbound, at capacity southbound. The segment north of the gate has acceptable congestion levels in both directions. In the future, a slight deterioration is expected for the directions approaching the entrance to the Air Force Base. Under Packages 1 and 2, in which Airport Road is closed, the northbound direction is projected to experience forced-flow AM-peak-hour conditions, with long delays. Under Package 3, the connector is expected to absorb a portion of the Wood Street traffic, thereby upgrading its level of service to better than existing conditions. Package 4 has a slight positive effect on Wood Street. Under Package 7, Wood Street is expected to be at a level of congestion similar to that under Package 1.

During the PM peak hour, the northbound conditions are good at present, and are expected to remain the same in the future and under all packages. However, the congestion in the southbound direction, which is at low to tolerable levels presently, is expected to deteriorate to forced-flow levels in the future. The same situation is expected under Packages 2, 4, and 6, which do not include the Hartwell Connector. Under Package 2 in particular, in which Airport Road is closed to traffic and the Wood Street gate is used by exiting traffic, the segment of Wood Street south of the gate is expected to operate under intolerable conditions southbound in the PM peak hour. Under Packages 3 and 5, the travel conditions on Wood Street southbound improve to acceptable levels, owing to the attraction of the connector. Under Package 7, in which Airport Road is closed and the Hartwell Connector is present, the congestion is slightly improved over the future no-build case.

Bedford Road (Lincoln), South of Route 2

This roadway has good travel conditions presently and is expected to remain the same in the future no-build case and under Packages 1, 2, 5, and 6. However, Packages 3, 4, and 7 are projected to be somewhat disadvantageous. The grade separation of the intersection of Route 2 and Bedford Road will reinstate presently prohibited turning movements at that location; therefore, Bedford Road is expected to carry additional traffic to and from Route 2.

Bedford Road (Lincoln) from Route 2 to Route 2A (Great Road)

The presently good travel conditions southbound in the AM peak hour and northbound in the PM are expected to continue in the future no-build case and under all packages. In the opposite directions there is a localized congestion problem which is expected to increase somewhat in the future no-build case and under packages 3, 4, 5, 6, and 7. This portion of Bedford Road is closed to Route 2A traffic in Packages 1 and 2.

Lexington Road (Lincoln), South of Route 2

This roadway segment presently operates under good travel conditions. The same is projected for the future no-build case and under all packages.

3.3 SUMMARY OF IMPACTS BY ALTERNATIVE PACKAGE

This section provides a broad summary of impacts, by package, on the HATS network as a whole. The arrangement of the first six packages is such that it calls for the analysis of their impacts in pairs: Packages 1 and 2, 3 and 4, and 5 and 6. The two packages in each pair are identical in terms of improvements in the Route 2 and Route 2A corridors and different in the treatment of the Route 4/225 corridor in Bedford and Lexington. The analysis of each pair will begin with the first two corridors and continue with comparison of the Hartwell Connector and the widening of Bedford Street in the latter corridor. For the locations of the projects examined in this study, the reader is again referred to Figure 2-1.

Packages 1 and 2

The full relocation of Route 2A benefits a number of roadway segments along this corridor: the relocated Route 2A east of Hanscom Drive, the Cambridge Cutoff east of Crosby's Corner (actually a portion of the relocated Route 2A), Lexington Road west of Merriam's Corner, Old Bedford Road in Concord south of Route 62, Mill Street in Lincoln, and Bedford Street in Lincoln.

The negative traffic impacts are generally minor, with one exception. The closure of Airport Road has a serious impact on Wood Street in Lexington. Hartwell Avenue is somewhat negatively affected, for the same reason. One of the more notable minor impacts is on Virginia Road in Lincoln, in the northbound direction during the PM peak hour. Congestion increases here because higher volumes are attracted following the closure of the present Route 2A between Hanscom Drive and Merriam's Corner.

In Package 1, the Hartwell Connector affects a number of roadway segments. Positively affected segments include Wood Street, Bedford Street, Westview Street, Maguire Road, and Hartwell Avenue (between Bedford Street and Maguire Road) in Lexington, and Page Road, Pine Hill Road, Winter Street, and Spring Road (north of Pine Hill Road) in Bedford. Negatively impacted roadways are Spring Road (south of Pine Hill Road), Route 62 (between Routes 4/225 and Page Road), South Street, and Wiggins Avenue. Generally, it is expected that the Hartwell Connector will attract--via Spring Road, Route 62, Wiggins Avenue, and, to some extent, South Street--traffic presently using Pine Hill and Page roads. The nature of the connector's impact is further explained in the portion of section 3.2 that discusses support roadways in northern Bedford and northern Lexington between Routes 4/225 and Route 3.

In Package 2, the widening of Bedford Street provides traffic relief to Bedford Street only. Generally, it encourages the processing of additional traffic via Bedford Street to and from north/south roadways such as Route 62, Spring Road, Billerica Road, and North Road. Routes 4/225, between Hartwell Avenue and North Road, are also somewhat negatively affected.

Packages 3 and 4

These packages are favorable to the corridor of Route 2 east of Route 126, the corridor of Route 2A east of Merriam's Corner, and, quite extensively, the area south of Route 2. The main reason for the benefits is the grade separation of Route 2 at two locations; a secondary reason is the eastern relocation of Route 2A. The grade separation at Crosby's Corner and Bedford Road is expected to be particularly beneficial, reducing delays and thereby increasing capacity along Route 2 between Route 126 and Route 128. The increased capacity is expected to attract traffic presently on Route 2A and Trapelo Road. Other positively impacted roadway segments are Route 126 south of Route 2, Baker Bridge Road, Sandy Pond Road, Mill Street, Lexington Road, and Old Bedford Road (Concord). Roadway segments which are adversely affected are the Cambridge Turnpike in Concord and Bedford Road in Lincoln. These roadways are projected to suffer somewhat from the facilitation of traffic movements via Crosby's Corner and the grade separation of the intersection of Route 2 with Bedford Road. However, the increase in traffic is slight, and not sufficient to alter the present travel conditions at Concord Center or Lincoln Five Corners.

The impacts of the Hartwell Avenue Connector (Package 3) and the widening of Bedford Street (Package 4) are expected to be as described for Packages 1 and 2, with the exception that in Package 3 Wood Street is projected to operate at acceptable congestion levels. In this case Airport Road is open and the Hartwell Connector attracts traffic from Wood Street.

Packages 5 and 6

Under these packages, Route 2 is projected to have the same congestion level as in the future no-build case. Route 2A benefits less from its eastern relocation, however, than under the previous four packages; the improvement in travel conditions is expected to be primarily between Airport Road and Merriam's Corner, in both directions.

The Hartwell Connector in Package 5 and the widening of Bedford Street in Package 6 have approximately the same impacts as in Packages 1 and 2.

Package 7

This package contains the largest number of positively affected roadway segments in the areas along Route 2 and Route 2A. However, the travel conditions along them are within roughly the same congestion-level categories as under Packages 1, 2, 3, and 4. These positively impacted roadway segments are concentrated along and to the south of the relocated Route 2A, east of Crosby's Corner. West of Crosby's Corner, along and to the north of Route 2, the impact of this package is rather neutral. The closure of Airport Road has approximately the same negative impacts on Wood Street as in Packages 1 and 2.

The effect of the Hartwell Connector is the same as discussed for Packages 1 and 2.

Comparison of Packages

In summary, Package 7 provides the most traffic-flow improvements, followed by Packages 3 and 4, Packages 1 and 2, and Packages 5 and 6. The ranking of packages within pairs is not clear, although careful evaluation of the overall impacts from the widening of Bedford Street and the Hartwell Connector suggests that the widening is marginally more beneficial than the connector.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

Parts of the roadway system in the HATS area suffer from excessive delays during the AM and PM peak hours. The higher volumes which are projected for the area in the future are expected to worsen travel conditions even further on problem roadway segments and to bring about congested conditions on segments not currently problematic.

The conclusions of this study regarding the proposed projects are summarized below (the locations of these projects are shown in Figure 2-1). The reader should be reminded that the widening of Route 3 was an assumption in the analysis. This improvement is expected to have a positive impact on Route 3 itself and on the HATS highway network in general. The type of analysis given in this study to other improvements to the network was not given to the widening of Route 3, which was a component of the 1995 no-build case.

The Route 2 flyover at Crosby's Corner is successful in relieving congestion at the Corner, owing to the added capacity and the separation of the through from the local Route 2 traffic.

The Route 2/Bedford Road grade separation in Lincoln has minor adverse effects on Bedford Road south of Route 2, because it allows for certain movements which are presently prohibited.

The combined effect of the two Route 2 grade separations just mentioned is positive for Route 2 between Route 126 in Concord and Route 128 in Lexington. There is no effect on congestion on Route 2 west of Route 126. However, the positive impacts from the Route 2 improvements reach beyond its immediate corridor boundaries to Route 2A, Trapelo Road, Route 126, and Sandy Pond Road in Lincoln. The effect of the improvements on Route 117 is rather neutral.

The western relocation of Route 2A in Lincoln is successful in alleviating congestion at Merriam's Corner and on Route 2A at Hanscom Drive and east of it. Hanscom Drive is capable of carrying comfortably the traffic diverted off the present Route 2A. The closure of Airport Road is of minor benefit to Marrett Road and causes forced-flow conditions on Wood Street.

The eastern relocation of Route 2A is of benefit to the intersection of Route 2A with Hanscom Drive and, to some extent, to Route 2A east of that point.

The Hartwell Connector in Bedford and Lexington has localized positive impacts on Bedford Street and Wood Street in Lexington. It also attracts traffic from the area north of Routes 4/225 and from Hartwell Road via Wiggins Avenue and South Road, thus reversing the peak direction of travel in the evening on certain roadways in the area. The Hartwell Connector is of no benefit to Routes 4/225 west of Hartwell Avenue.

The widening of Bedford Street is also of localized benefit. However, the additional capacity encourages traffic to divert to it and then northbound to already congested north/south roadways, such as Route 62.

4.2 RECOMMENDATIONS

Route 2 (Concord, Lincoln, and Lexington)

The proposed improvements on Route 2 afford relief to Route 2 between Route 126 in Concord and Route 128 in Lexington. They also benefit Route 2A and other roadways in Lincoln. The improvements provide no relief to Route 2 west of Route 126, where travel conditions are expected to become worse in the future; therefore, the proposed improvements are not recommended as a mechanism to alleviate traffic congestion on Route 2 for its total length in the study area. Because the vehicle delays at Crosby's Corner and the high accident rate there (addressed in HATS Phase I) are excessive, and these delays affect other roadways in the vicinity as well, it is recommended that the flyover be given priority consideration over the grade separation at Bedford Road.

Route 2A (Lincoln and Lexington)

This roadway benefits far more from its western relocation than from its eastern relocation. However, looking at the Route 2A and Route 2 corridors together and comparing Route 2A benefits from even the full relocation to those from the Route 2 improvements shows that Route 2A travel conditions derive greater benefit from the Route 2 projects. Therefore, the western relocation can not be justified by traffic considerations alone if both of the Route 2 grade-separation projects are planned. However, it is recommended if only the flyover at Crosby's Corner is to be constructed.

Airport Road (Lexington)

Access to Airport Road should remain available to Air Force Base traffic: removing it would cause forced-flow conditions on Wood Street.

Hartwell Connector (Bedford and Lexington)

The proposed Hartwell Connector is projected to be less effective than expected, clearly not capable of restoring acceptable travel conditions on Routes 4/225. Therefore, pursuing it further is not recommended until improvements are made on Route 128.

Bedford Street (Lexington)

The proposed widening of Bedford Street offers virtually no relief to any portion of Routes 4/225 in the study area, and is not recommended. Solutions to the traffic problems of this corridor may possibly be found in transportation-systems-management (TSM) measures for improving traffic operations at intersections and along roadway links.

APPENDIX A UPDATING AND IMPROVING THE HATS PHASE I TRAFFIC-FORCASTING PROCEDURE

The traffic-forecasting model used for HATS Phase I was one developed by Federal Highway Administration (FHWA) and originally applied in 1975 by CTPS in the Northwest Public Investment Review Project (NWPIRP). The study area for that project was the northwest corridor of the eastern Massachusetts region, and consisted of 245 zones. Of those zones, 66 were in Acton, Bedford, Burlington, Carlisle, Concord, Lexington, and Lincoln. In order to reflect existing traffic conditions (1983 for phase I), the highway network was updated for changes between 1975 and 1983. The 1975 AM-peak-hour trip table was updated for population and employment growth and calibrated to 1983 AM-peak-hour traffic counts. These counts were taken in the area immediately surrounding Hanscom Air Field, including portions of Bedford, Concord, Lexington, and Lincoln.

The MDPW, in consultation with CTPS, suggested the following changes to the traffic-forecasting procedure for phase II:

- o Reduce the size of the study area from the entire northwest corridor to the area defined by Route 128 to the east, the Middlesex Turnpike to the northeast, the Bedford and Concord town lines to the north, Route 27 to the west, and Route 117 to the south. Included in this area are Bedford, Concord, Lincoln, and portions of Lexington, Acton, Maynard, and Sudbury. The new definition of the study area, while retaining the regional character of the model, would reduce significantly the computer time required and increase the feasibility of using a microcomputer model. In addition, it made sense to drop the parts of the network in which the committee had no immediate interest.
- o Investigate the possibility of introducing a traffic model to be used with a microcomputer. This would add flexibility to the use of the model and make it accessible to committee members for other traffic-impact applications.
- o Recalibrate the model with available 1984-85 traffic counts from an area wider than that covered by the 1983 MDPW counts. Suggested areas for expansion were the vicinities of Route 3 and Route 117.
- o Calculate traffic impacts for both the AM and PM peak hours. HATS Phase I, owing to the limited time allocated for the study, had dealt with the AM peak hour only.

Update of the Traffic Model

The first task of the model update was to "translate" the phase I model from the FHWA code to the Urban Mass Transportation Administration (UMTA) code. This change was judged necessary since the FHWA has ceased to support its package, while the UMTA package, which is easier to use and offers a variety of additional features, receives regular updates. The support issue is important in this case, since the HATS model is meant to be used in the area for other applications after this study. Another critical issue was that the "windowing" or isolation of the highway network of the redefined study area from the original network could only be achieved through the UMTA program NAG (Network Aggregation).

Following the change to the UMTA code, the links where the original network had to be "cut" were entered into the NAG program. NAG's outputs were the highway network and the AM-peak-hour trip table for the new study area.

A series of further editing procedures followed, involving external (and some internal) zone aggregations and coding changes for links and/or nodes from the network description. During this phase, the capacities of major roadway segments were reviewed and modified as necessary.

The end results of the editing process to this point were a roadway network which consisted of 75 zones, 1660 links, and approximately 800 nodes, and a preliminary 75-zone-by-75-zone AM-peak-hour trip table for 1983.

Calibration of the AM- and PM-Peak-Hour Trip Tables

The next step in the process was to update the 1983 AM-peak-hour trip table to a preliminary 1985 (HATS II base year) trip table. Since the 1995 growth factors from phase I were produced from 1995 employment and population data reviewed and approved by the HATS Committee during phase I (CTPS Technical Report 44, pp. 23 and 30), proportions of these factors were used to update the 1983 AM trip table to 1985.

Further "tuning" of the model required the calibration of the preliminary 1985 trip table to 1985 traffic counts. Since systematic traffic counting was not possible for phase II, available 1985 traffic-count data were collected from a variety of sources. Also, the 1983 MDPW counts which were collected for phase I were updated to 1985 using appropriate growth factors. A list of AM- and PM-peak-hour traffic counts for approximately 90 locations was compiled for the fine adjustment of the morning and evening trip tables (the preliminary 1985 evening trip table was created by inverting the 1985 morning trip table).

The calibration of the AM- and PM-peak-hour tables was performed using the microcomputer software package ME2, developed by Transware, Inc. The ME2 (Maximization of Entropy 2) model is a capacity-restraint iterative algorithm which, by starting with an initial trip table and taking into account the observed link volumes, estimates the "most likely" origin-destination trip table.

Finally, the 1995 (HATS II horizon year) AM- and PM-peak-hour trip tables were obtained by applying the 1995 growth factors from HATS Phase I to the calibrated 1985 AM- and PM-peak-hour tables.

APPENDIX B APPLICATION OF THE HATS II TRAFFIC-FORECASTING MODEL

Once the improvements to the "base" or existing highway network had been completed, a series of seven other networks, one for each of the seven alternative network packages, was coded. The lengths of the new links were calculated from highway maps (scale: 1 inch equals 2000 feet). The speeds and capacities assigned to the new links were based on knowledge of the area and of the link types. The coordinates of the new nodes were calculated, for plotting purposes, from the existing coordinate system.

The next step of the process was the "assignment" of the 1995 AM- and PM-peak-hour trip tables to the base and the seven alternative packages. This step involved the "loading" of the trip exchanges between the 75 traffic zones onto the highway links forming a number of minimum travel-time paths (Equilibrium Traffic Assignment) between each origin and each destination. In order to take into consideration the capacity of the roadway segments, this process was repeated nine times, with each iteration generating minimum travel-time paths based on the congested times derived from the trip loading of the previous iteration.

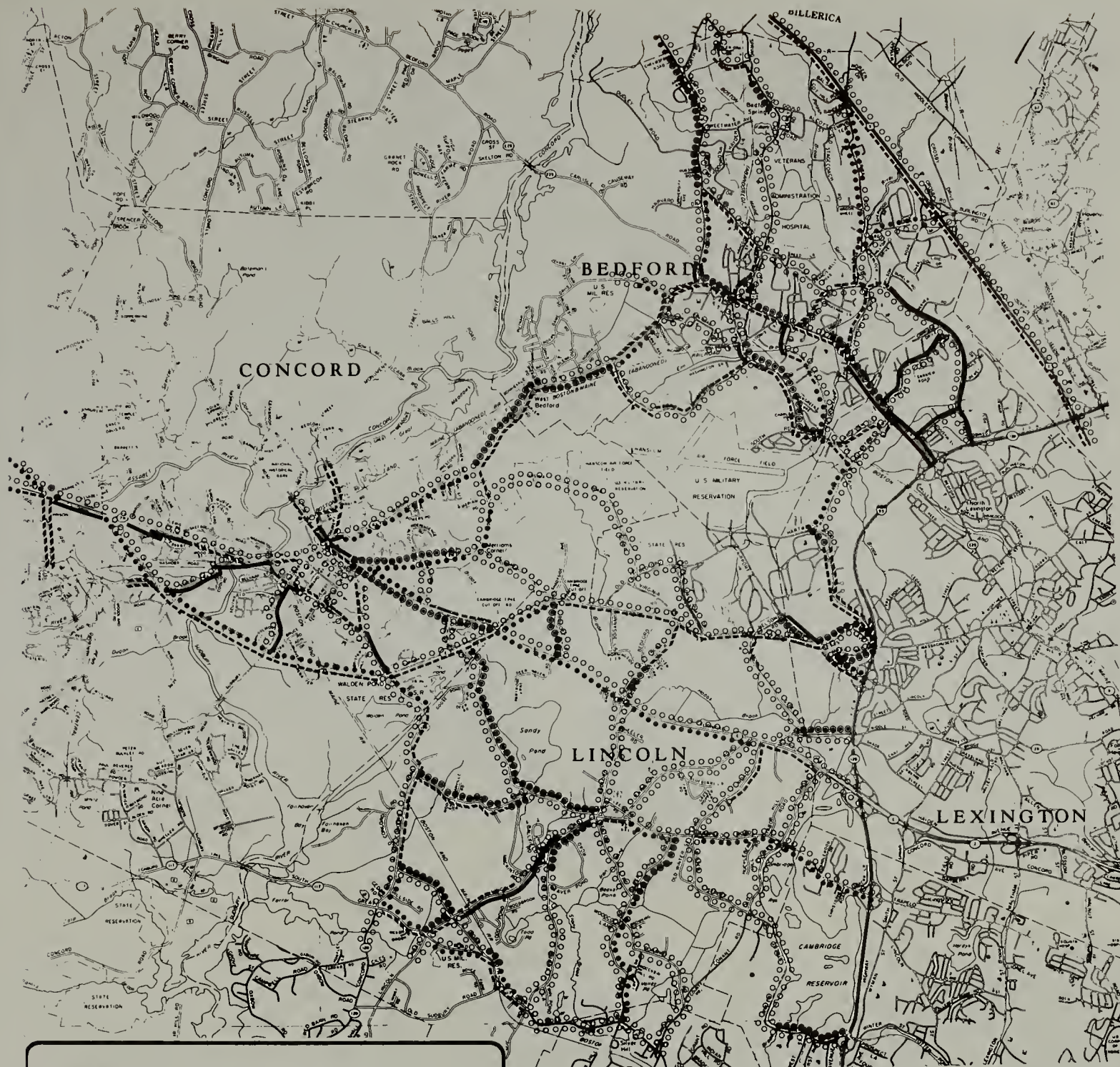
The direct output of the traffic assignments for each of the alternatives was 1995 link volumes and volume-to-capacity ratios.

APPENDIX C

TRAVEL CONDITIONS
IN THE AM AND PM PEAK HOURS

1985 Base Case
1995 No-Build Case
Packages 1 - 7

Figures C-1 - C-18
(itemized in List of Figures and Tables, p. v)



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 0.00-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC.
● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC.
• • • •	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC.
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC, SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE.
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENSIVE PERIODS OF TIME POSSIBLE.
— — — —	6 1.50*	

Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

1985 BASE TRAVEL CONDITIONS,
AM PEAK HOUR

CTPS

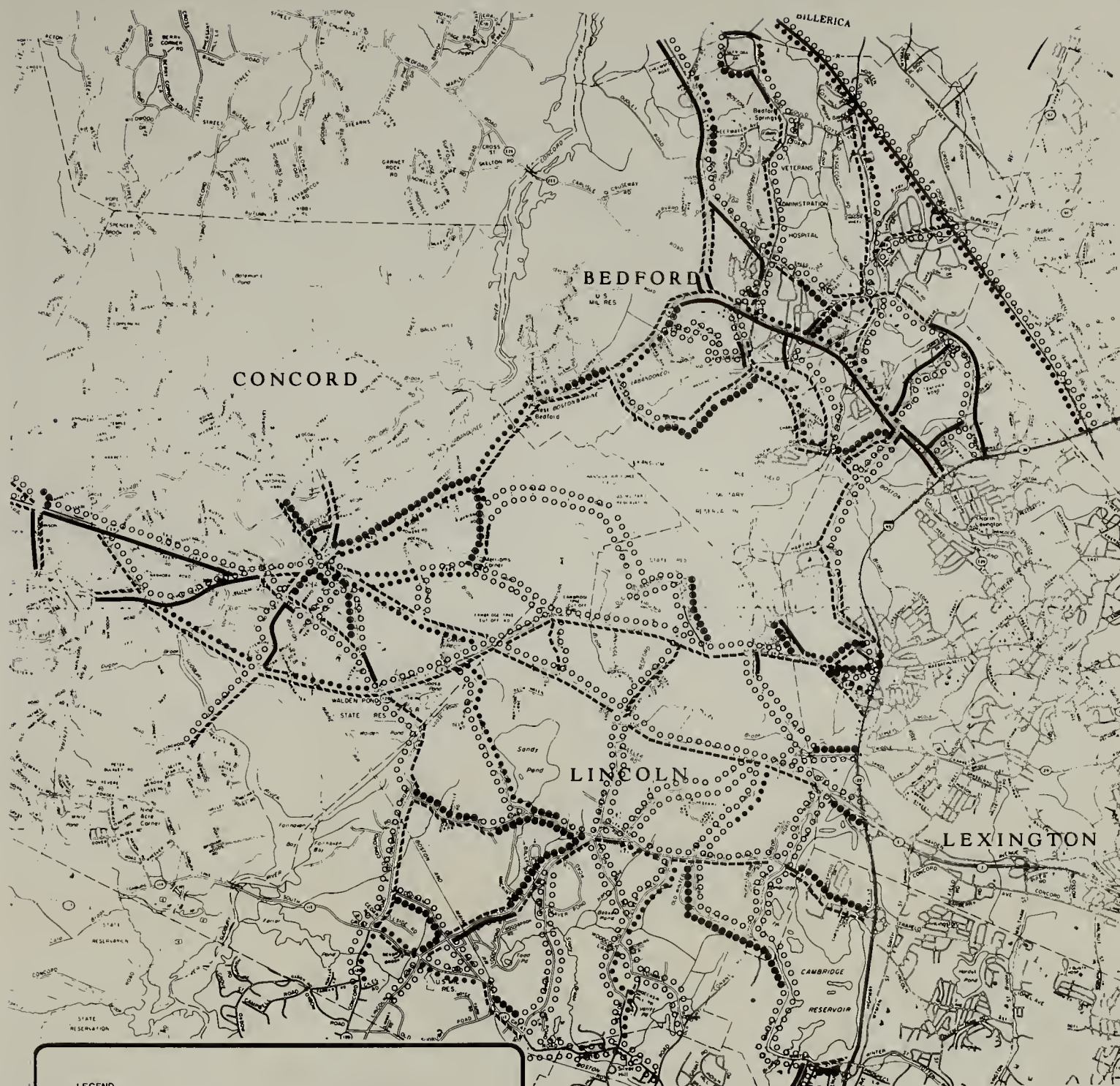
FIGURE

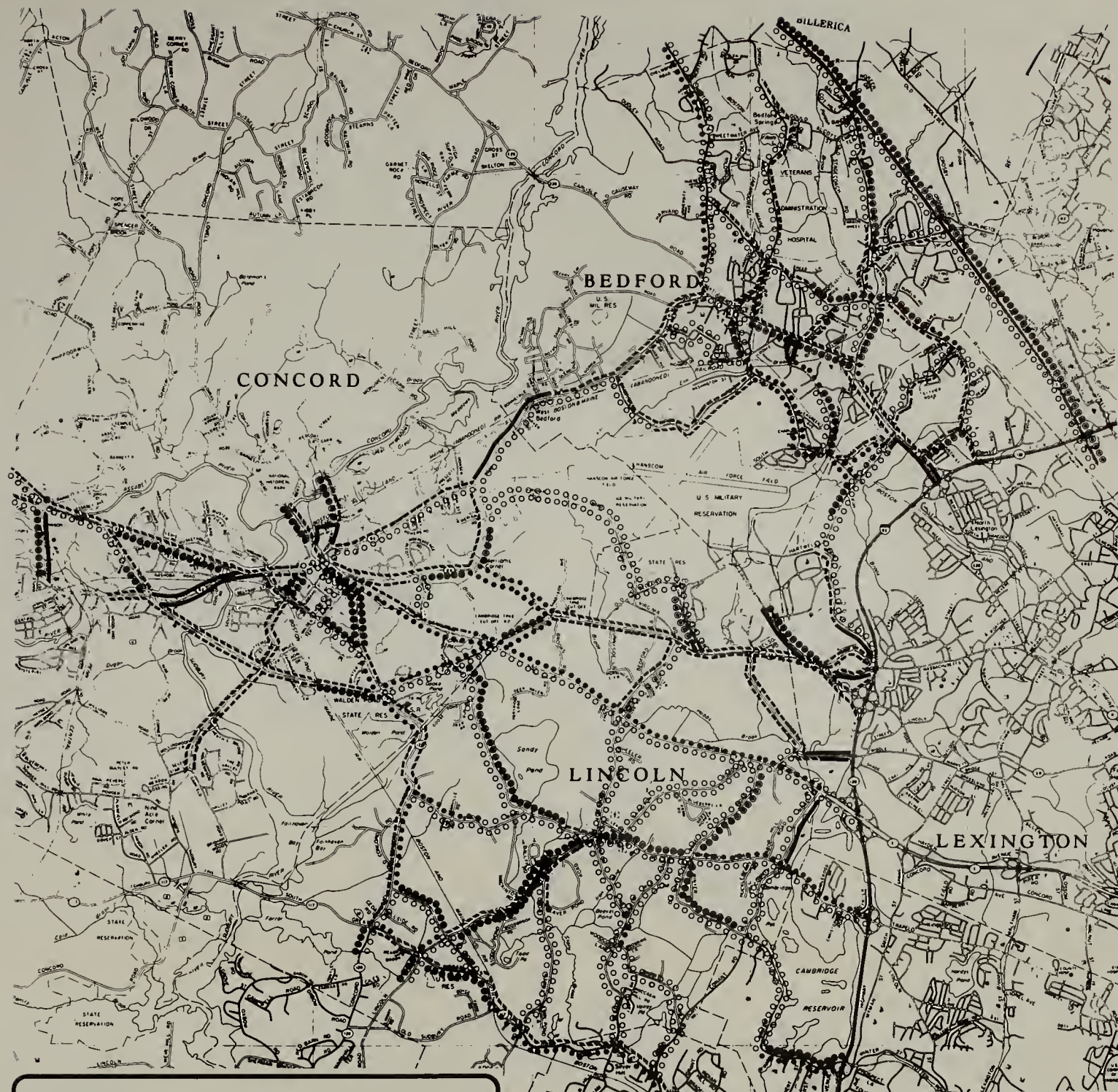
C-1



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.84	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50*	





LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 0.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.40	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50*	

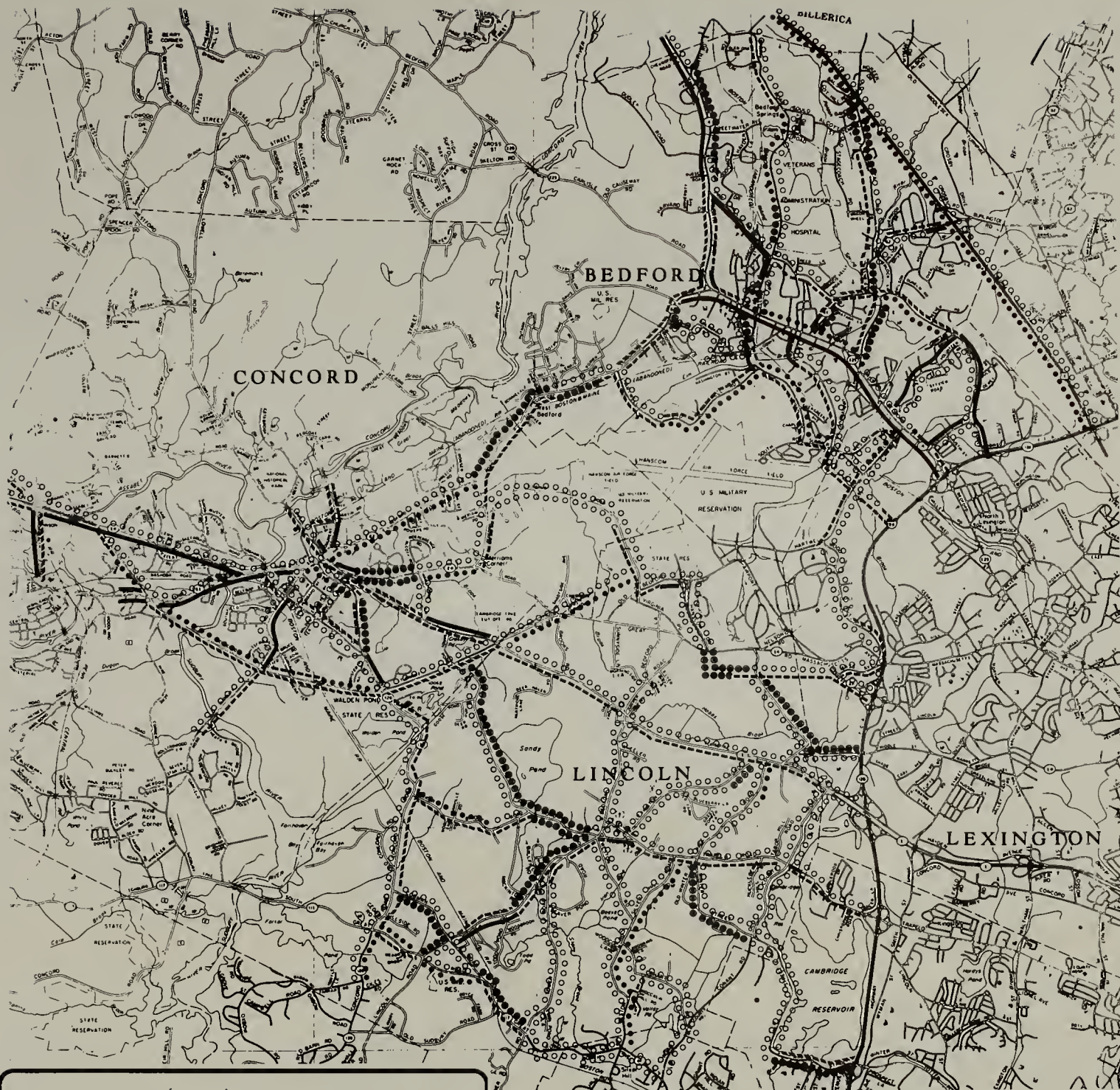
Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

1995 NO-BUILD TRAVEL CONDITIONS, PM PEAK HOUR

CTPS

FIGURE
C-4



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50*	

Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

PACKAGE 1 TRAVEL CONDITIONS, AM PEAK HOUR

CTPS

FIGURE
C-5



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50+	



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 00.0-0.69	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC.
● ● ● ●	2 0.80-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC.
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC.
- - - -	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC, SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE.
- - - -	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE.
- - - -	6 1.50+	

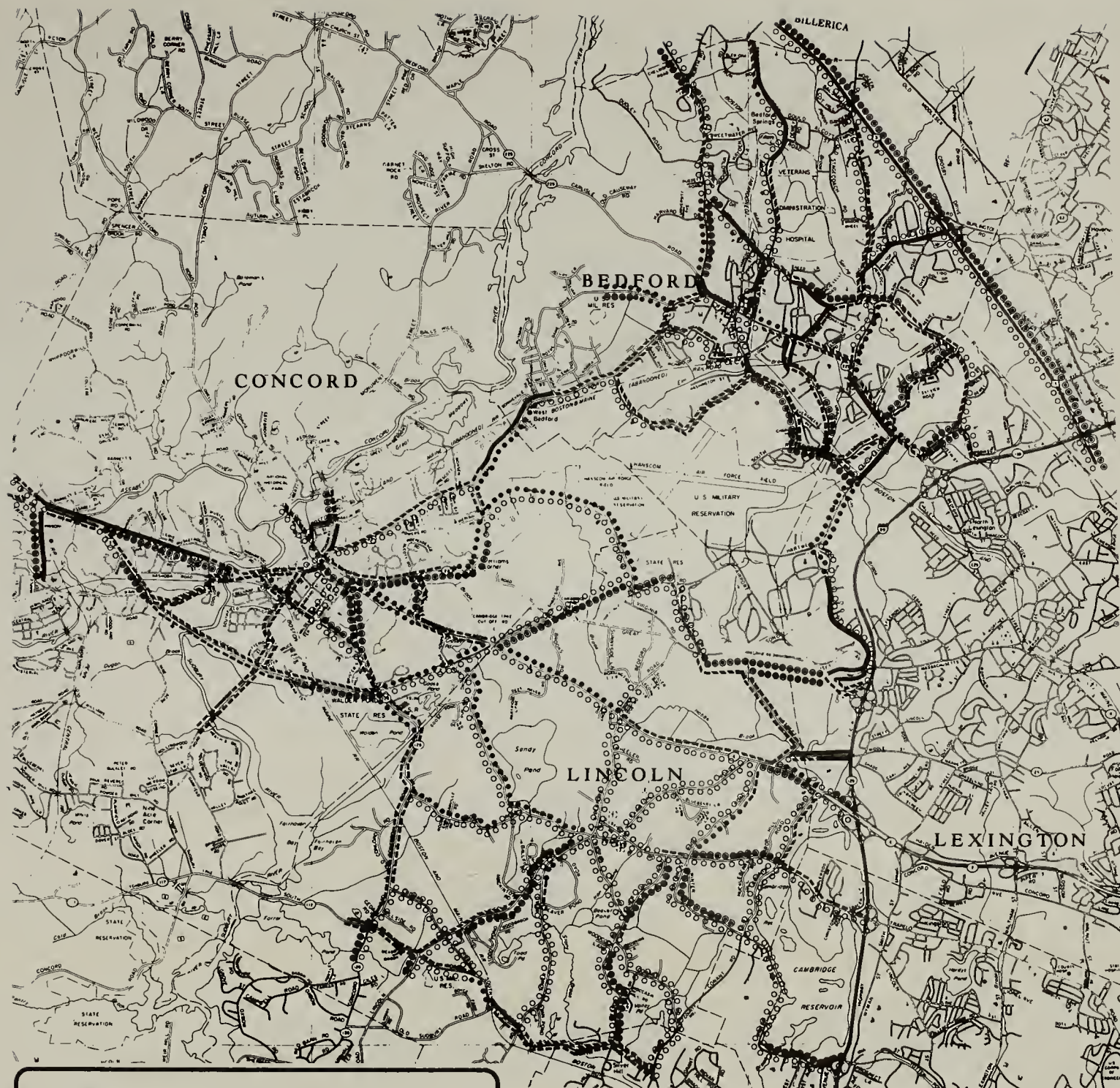
Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

PACKAGE 2 TRAVEL CONDITIONS, AM PEAK HOUR

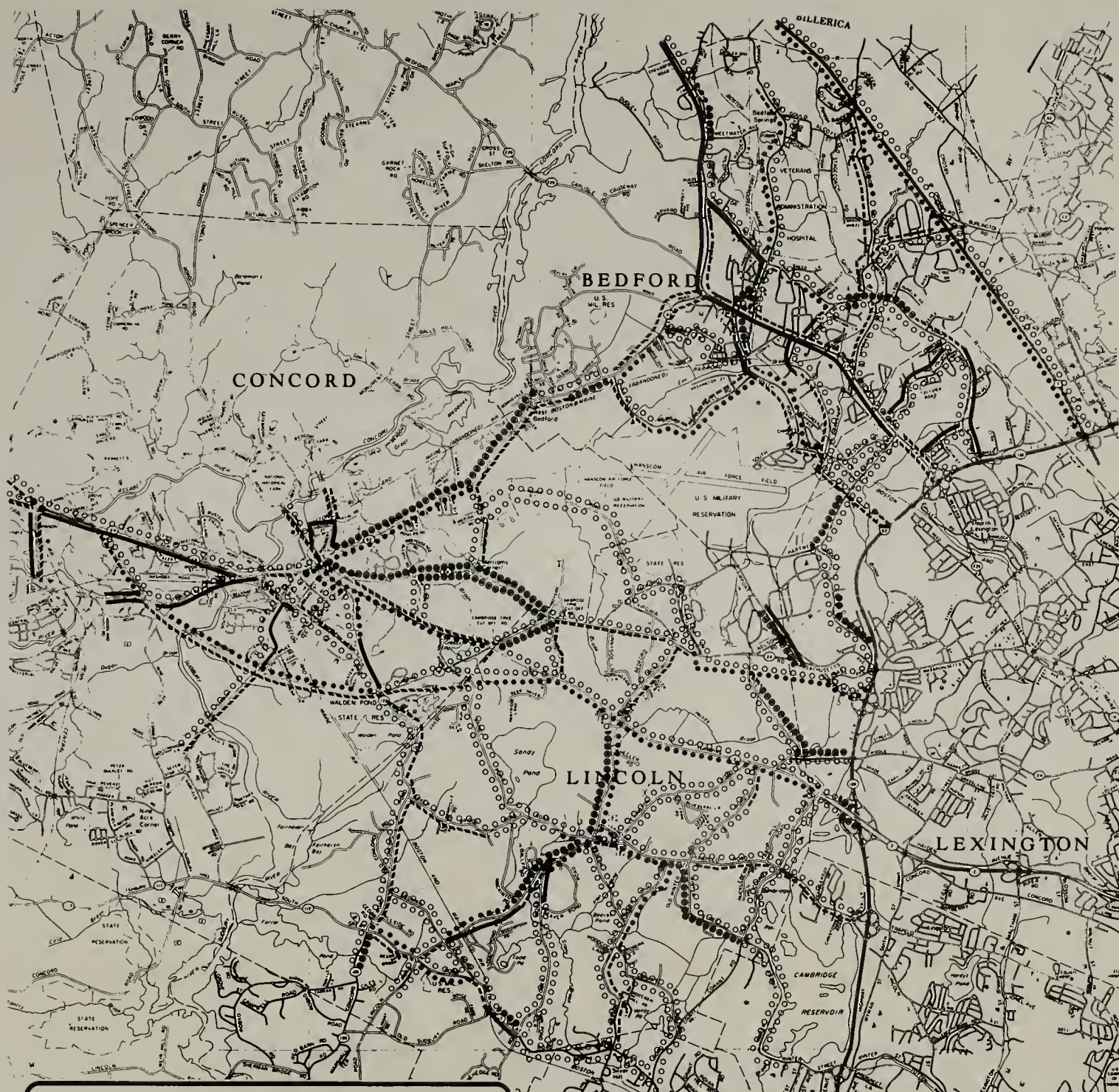
CTPS

FIGURE
C-7



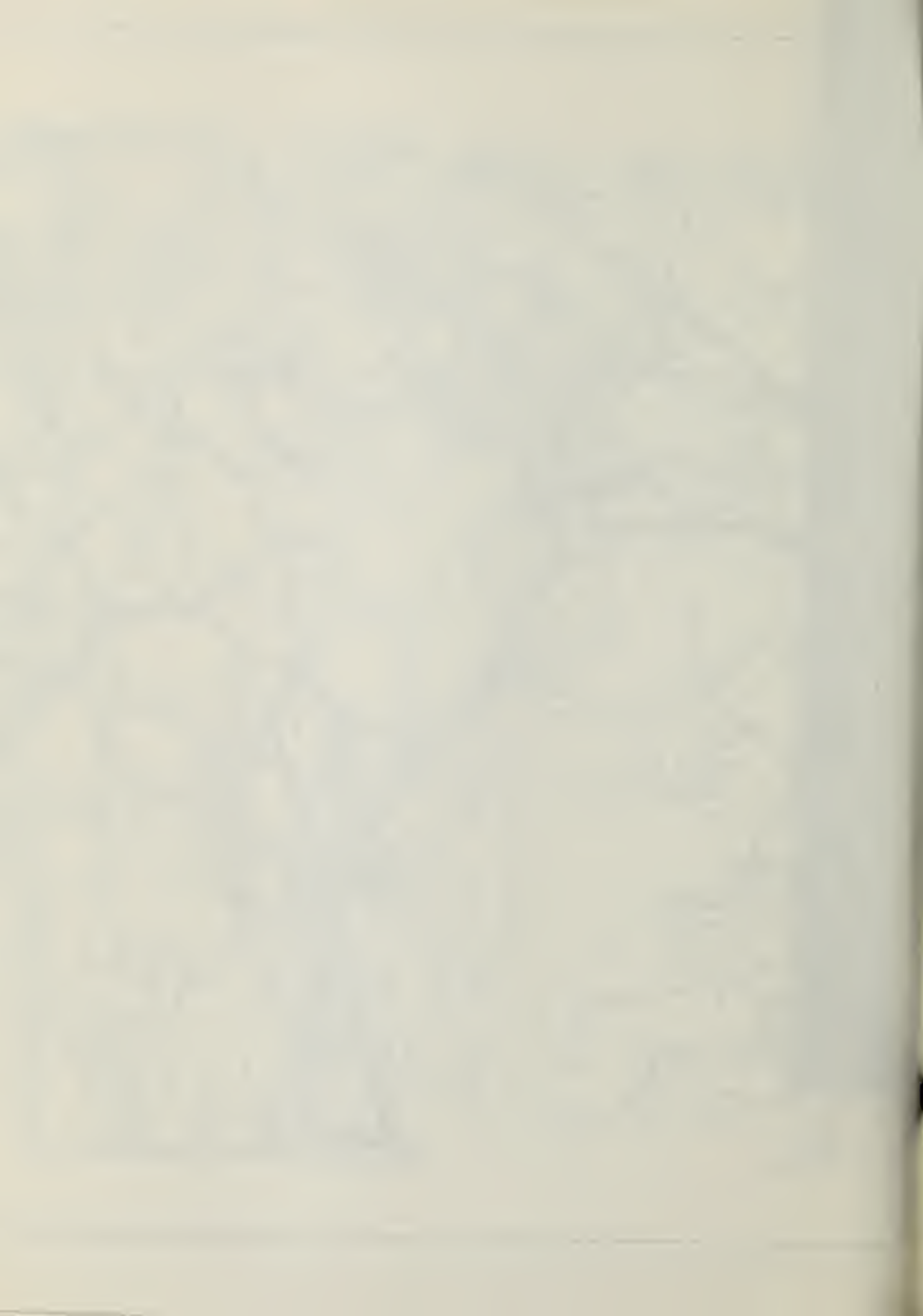
LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC, SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50*	



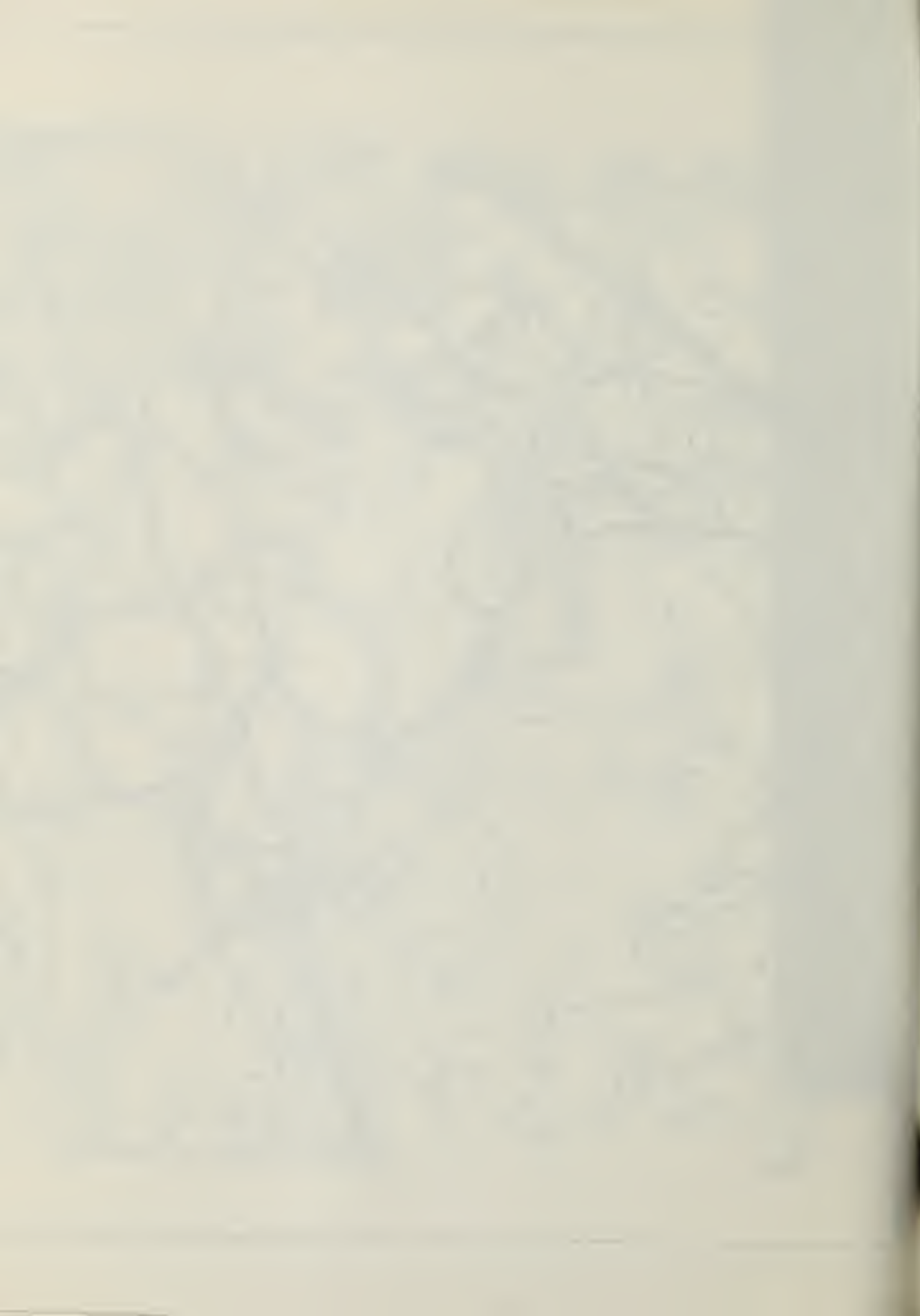
LEGEND

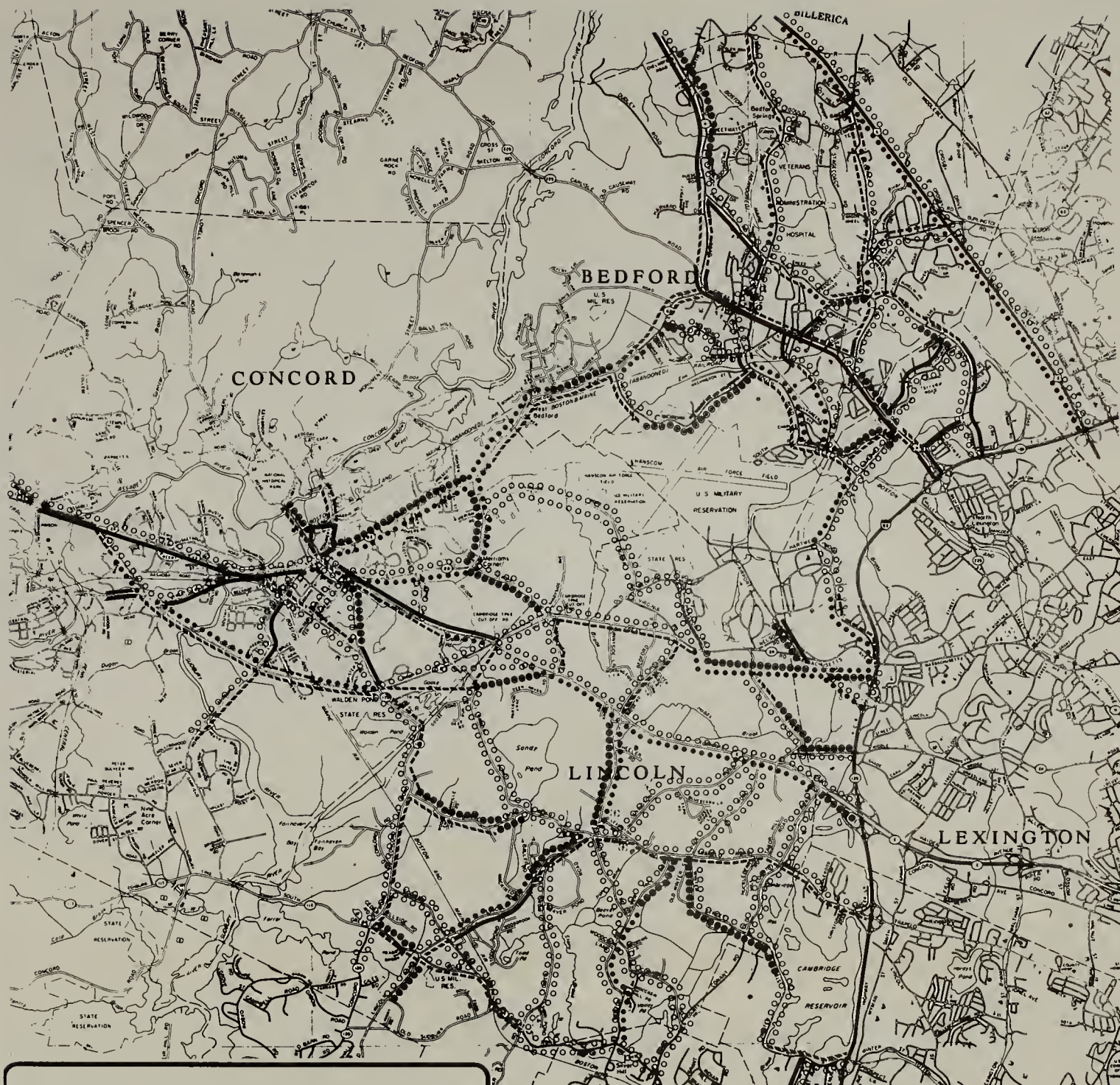
CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○○○○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
●●●●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
●●●●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
----	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
----	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
----	6 1.50*	





LEGEND		
CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 0.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50*	





LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 0.00-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC, SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE.
— — — —	6 1.50+	

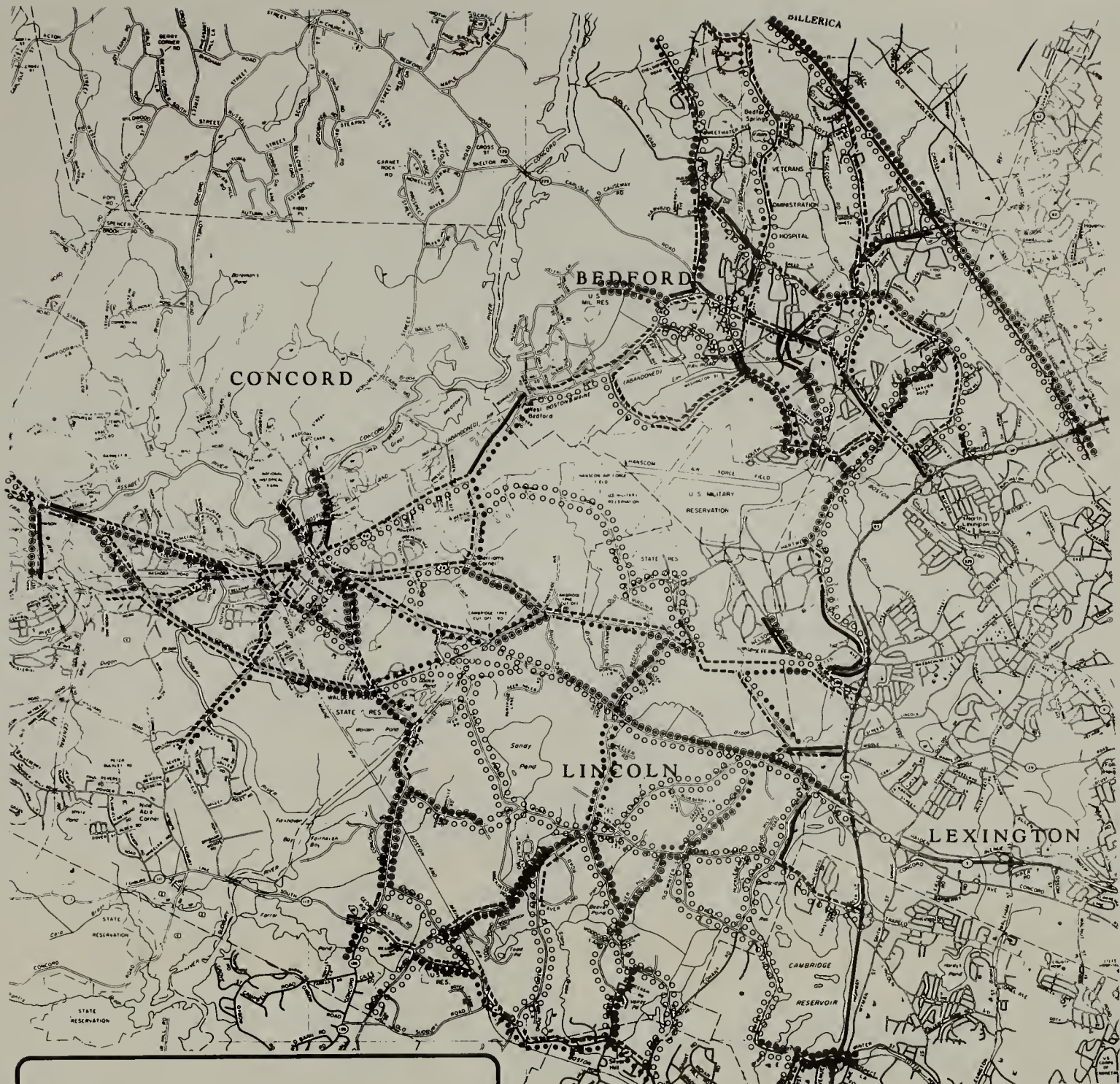
Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

PACKAGE 4 TRAVEL CONDITIONS, AM PEAK HOUR

CTPS

FIGURE
C-11



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○○○○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
●●●●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
●●●●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
----	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
----	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
----	6 1.50+	





LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
0000	1	00.0-0.59 LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
●●●●	2	0.60-0.79 MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
●●●●	3	0.80-0.94 MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
-----	4	0.95-1.14 HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC, SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
=====	5	1.15-1.49 VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
=====	6	1.50*

Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

PACKAGE 5 TRAVEL CONDITIONS, AM PEAK HOUR

CTPS

FIGURE
C-13



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○○○○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
●●●●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
●●●●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
----	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC, SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
----	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
----	6 1.50+	

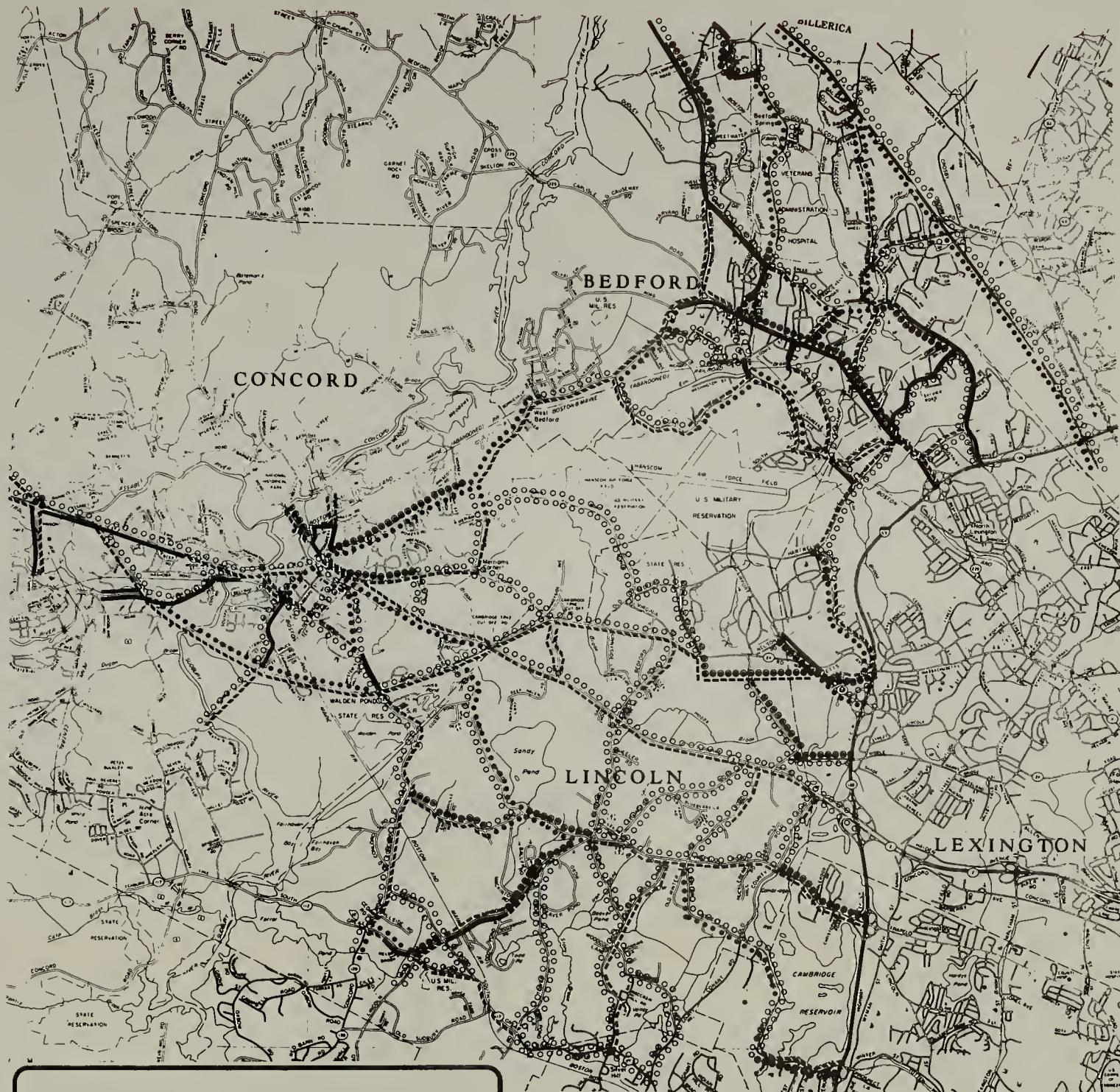
Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

PACKAGE 5 TRAVEL CONDITIONS, PM PEAK HOUR

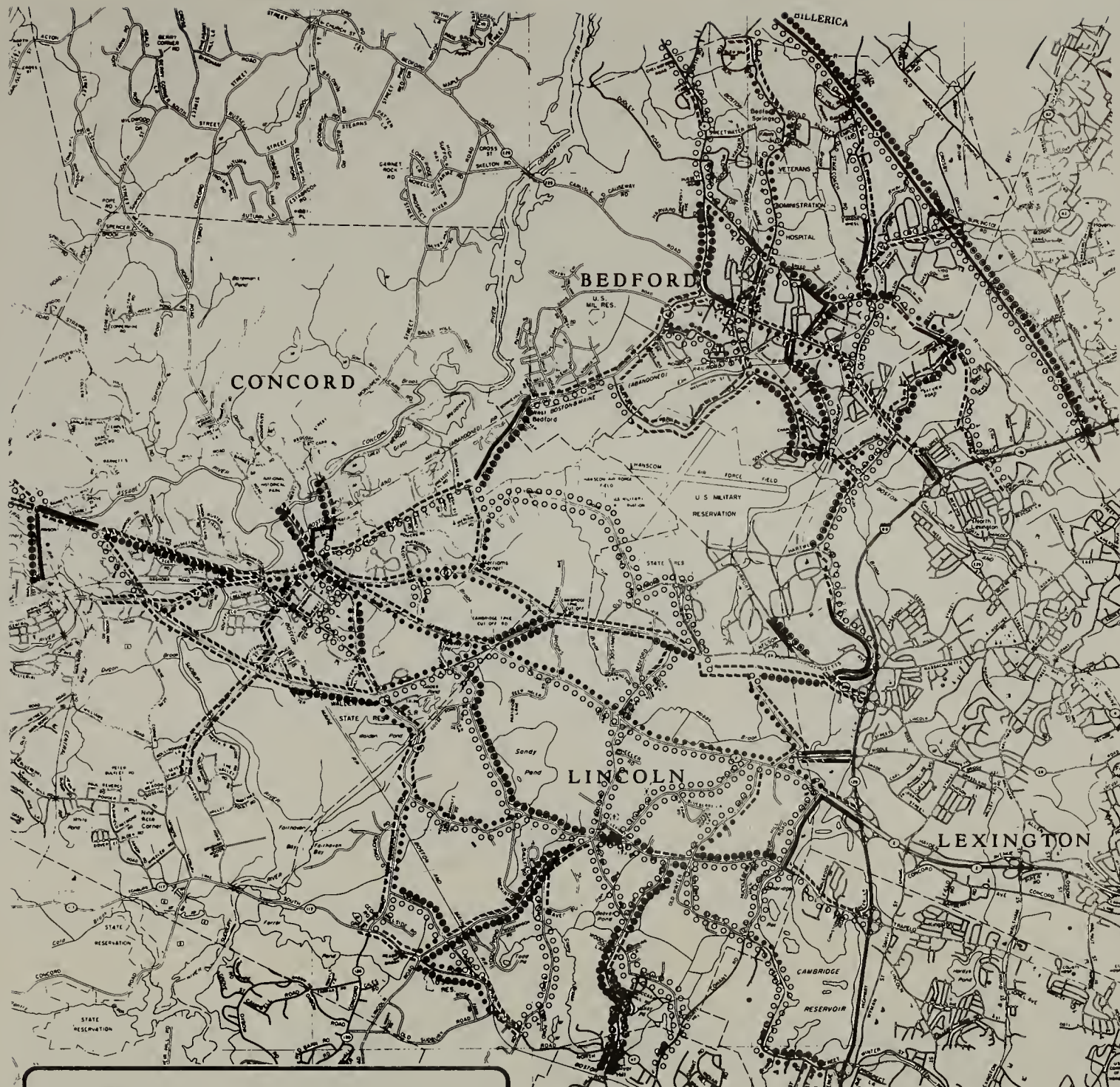
CTPS

FIGURE
C-14



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.40	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50+	



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC, SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50+	

Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

PACKAGE 6 TRAVEL CONDITIONS, PM PEAK HOUR

CTPS

FIGURE
C-16



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1 00.0-0.59	LIGHT VOLUMES OF RELATIVELY FREE FLOWING TRAFFIC
● ● ● ●	2 0.60-0.79	MODERATE VOLUMES OF RELATIVELY SMOOTHLY FLOWING TRAFFIC
● ● ● ●	3 0.80-0.94	MODERATE TO HEAVY VOLUMES OF RELATIVELY SLOW BUT STEADILY MOVING TRAFFIC
— — — —	4 0.95-1.14	HEAVY VOLUMES OF RELATIVELY SLOW TRAFFIC, SUBJECT TO FLUCTUATIONS IN OPERATING CONDITIONS AND RESTRICTIONS TO FLOW OF A TEMPORARY NATURE
— — — —	5 1.15-1.49	VOLUMES THAT SUBSTANTIALLY EXCEED THE CAPACITY OF THE ROADWAY WITH RESULTANT UNSTABLE FLOW AND STOPPAGE OCCURRING FOR EXTENDED PERIODS OF TIME POSSIBLE
— — — —	6 1.50*	

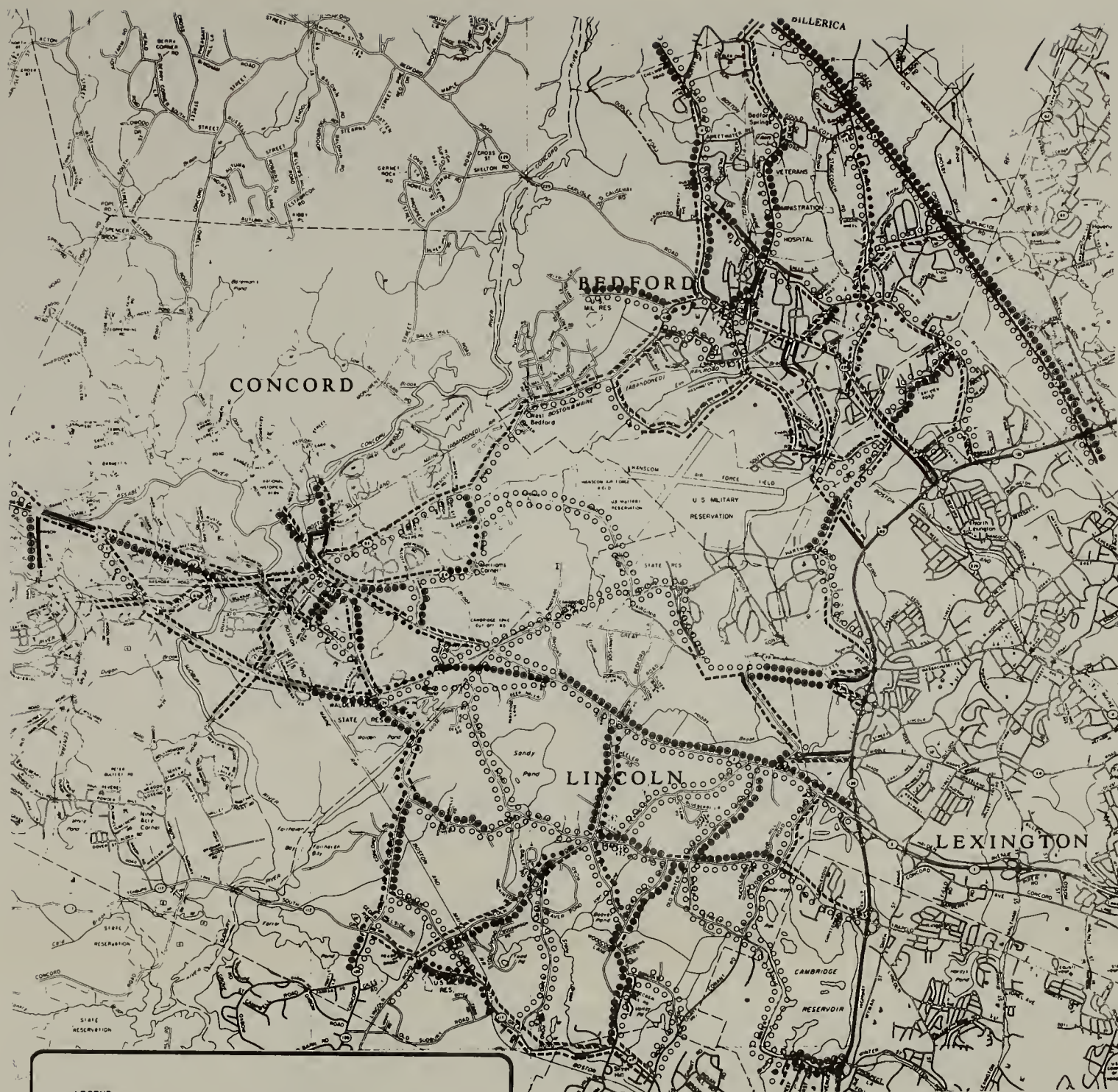
Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

PACKAGE 7 TRAVEL CONDITIONS, AM PEAK HOUR

CTPS

FIGURE
C-17



LEGEND

CONGESTION LEVEL	VOLUME/CAPACITY RANGE	DESCRIPTION OF TRAVEL CONDITIONS
○ ○ ○ ○	1	0.0-0.50
● ● ● ●	2	0.60-0.70
● ● ● ●	3	0.80-0.94
— — — —	4	0.95-1.14
— — — —	5	1.15-1.49
— — — —	6	1.50*

Hanscom Area Traffic Study:
Phase II

Technical Report 60
July 1987

PACKAGE 7 TRAVEL CONDITIONS, PM PEAK HOUR

CTPS

FIGURE
C-18

